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THE SYSTEM OF THE STARS.

The System of the Stars. By Agnes M. Clerke. (London: Longmans, Green, and Co., 1890.)

THE gifted author of this work became justly famous by the publication of her now classical "History of Astronomy during the Nineteenth Century." The mass of accurate information there brought together, and the delightful way in which it was related, won well-earned praise on every hand. Her success in that effort has now encouraged her to a more ambitious one. In addition to the simple relation of facts, she ventures to give her opinions on the various inferences which have been drawn from them by those who have spent many years in elaborate investigations. Still, "the statement of facts has been kept primarily in view, but the more important efforts to interpret them have been noticed, and the difficulties attending rival theories impartially pointed out."

We may look upon the book as consisting of two parts, one simply presenting a most valuable mass of information, while the other gives the author's views on contemporary work. As far as the first part is concerned, Miss Clerke has done her work admirably. We regret, however, for her own sake, that she has not confined herself entirely to this kind of work. A trustworthy book, bringing together all the latest discoveries and views of competent judges as to their true meaning would have been priceless, and no one has better opportunities for such an undertaking than Miss Clerke. As it is, we find a certain amount of information, selected rather than complete, intermingled with her own views. Certain facts have been omitted, not with the intention of misleading, but because their importance was apparently not recognized.

The first two chapters give general ideas of the problems of sidereal astronomy, and the methods of research which are adopted. The third chapter deals with "Sirian and Solar Stars," and here we get the first glimmerings of the author's special leaning to what may be called the "electrical theory." There is little difficulty connected with these groups of stars: it is generally agreed that the Sirian are the hottest, and that they have a definite evolutionary connection with the solar ones. Like Vogel, the author includes amongst the Sirian stars those stars of Orion (*e.g.* Rigel) which are characterized by very few visual and comparatively few photographic lines. Although their spectra show hydrogen absorption conspicuously, they differ very widely from the Sirian stars in other particulars. Their structure is not improbably of a very different character, due no doubt to their connection with the great nebula. Condensations taking place away from such a widely-diffused nebulosity probably follow a different path, and for the present the Orion stars should be classed apart from the more perfectly formed ones of the Sirian type. *a* Cygni, again, is included amongst the "solar stars," although its spectrum exhibits very wide divergences from that of the sun; the characteristic structure about the G region is entirely absent, while there are many well-marked non-solar lines in its spectrum. Altair, also, is said to be located between the Sirian and solar stars; but here again there is little resemblance to either, beyond the lines of hydrogen; the diagram on p. 43 makes this sufficiently evident. The more the "solar stars" are studied, the more it seems probable, as Mr. Lockyer has pointed out, that they must be divided into two groups—one of increasing temperature, including such stars as Aldebaran, *a* Cygni, and Altair; the other of decreasing temperature, including such stars as Procyon, Capella, Arcturus, and the sun.

The author advocates that the difference between the Sirian and solar stars can be accounted for by assuming the solar stars to be the more strongly electrified. It is argued that an increase of temperature in such a star as the sun would increase rather than diminish the complexity of its spectrum, by increasing the absorbing metallic vapours. It is not evident, however, how a diminution of the electrical repulsion would cause such an increase of the hydrogen absorption as that indicated in the spectra of the Sirian stars, the author simply asserting that the layers of hydrogen would be much more concentrated than at present. The increased thickness of the hydrogen lines is more probably due to some cause which increases the quantity of hydrogen in the atmospheres, and for the present, at all events, that may be regarded as the dissociation of the metallic vapours due to the increased temperature brought about by condensation.

Chapter iv. deals with the stars having banded spectra. These, it is well known, are of two types—one showing dark flutings most probably of metallic vapours, and the other dark flutings of carbon. They form Secchi's third and fourth types respectively. Flutings undoubtedly indicate that the vapours producing them are at a comparatively low temperature, and the presumption would be that the red stars are cooler than the yellow and white ones. On this point it is remarked that "the alteration obviously implies an augmented extent of absorbing atmosphere. For the bands must originate in a region of less heat—that is, at a greater distance from the stellar photospheres than the lines."

Let us consider first of all the stars of the third type, in which the hottest members show a fluted spectrum superposed upon a line spectrum, whilst there are practically no indications of the hydrogen lines. It has been suggested on various grounds that the stars of this type are not stars in the true sense of the word, but that they are of a cometary nature; that is, that they are composed of discrete masses, and not of a photosphere surrounded by glowing vapours. Perhaps the chief evidence in favour of this view lies in the alleged existence, in the spectra of these stars, of the bright carbon flutings which characterize the spectra of comets. The author does not consider the evidence on this point conclusive, but this appears to be partly due to the fact that all the evidence has not been brought together. In Nova Orionis, with a well-marked spectrum of this type, Dr. Copeland demonstrated the presence of two of the cometary flutings with almost absolute certainty (*Monthly Notices R.A.S.*, vol. xlvi. p. 110); Messrs. Lockyer and Fowler showed them to be present in *a* Herculis and Mira Ceti (Proc. Roy. Soc., vol. xlvii. p. 35); and, more recently, Mr. Maunder has stated that in the spectrum of *a* Herculis the brightest green fluting is coincident in

position with the chief hydrocarbon band, and, moreover, presents exactly the same appearance ("Greenwich Spectroscopic Observations," 1888, p. 13). The brightening of this same fluting at the maximum of Mira tends to the same conclusion. Not a single one of these important observations, however, is referred to by Miss Clerke, although, if they are confirmed by future work, they must inevitably revolutionize the old idea that the red stars of the third type are "suns." The objection that the dark band adjacent to this, if an effect of contrast, would indicate that in the stars where it appears very dark there was no continuous spectrum at all does not hold good. A sun-spot appears intensely dark by contrast with the surrounding photosphere, and yet we know that it is brighter than the electric light. It is further objected that the other two cometary bands do not present themselves; but the blue band was included in both Copeland's and Fowler's observations, and it must be remembered that the citron band is the faintest in comets, and that in the stars in question it may be masked by the dark flutings which fall near it. It is stated (p. 56) that "there are grave objections to admitting the reality of the masking," but, as these are not formulated, it is impossible to discuss them. Whether the masking be admitted or not, the third band seen in comets often assumes the positions of two of the apparent bright bands in the spectra of stars of the third type, and with the additional evidence of the other two flutings, it is only reasonable to suppose that comets and these stars are bound together by close ties of relationship. Hence we cannot agree that "conclusive evidence seems to be provided that stellar spectra of the third type originate at various heat-levels in powerfully ignited vaporous envelopes." The mere existence of a continuous spectrum cannot be regarded as evidence of the existence of a photosphere. Comets, as a rule, give continuous spectra in addition to their fluted radiation, but few would venture to assert that this is produced by the radiation of a photosphere. The case of Mira at maximum, when the hydrogen lines appear bright, is quoted as evidence of an intensely high temperature close to the supposed photosphere; but this, it should be added, is abnormal, and only occurs when, through some cause or other, the star is some hundreds of times its normal brightness.

In support of the view that the various phenomena presented by stars of this type are produced by a photosphere underlying a highly distended atmosphere, the observations of the intermittently hazy aspect of some of them is referred to. It is only necessary to add here a remark omitted by the author—namely, that this equally supports the "cometary theory" of their structure, and is, in fact, one of its essential points. The electrical theory is again brought to the front in connection with these stars, it being suggested (p. 61) that the red stars are more strongly excited than the Sirian and solar stars, and that, in consequence, the atmospheres are very widely distended.

Coming now to the other type of red stars, in which we get the cometary spectrum reversed, Miss Clerke is again in error. It has hitherto been pretty generally accepted that these stars are almost on the verge of extinction, but our author says that "their powerful incandescence is undoubted" (p. 64). The evidence of such a temperature depends upon very doubtful facts. In addition to the chief bands of carbon, the spectra exhibit six secondary bands, two of which agree almost in position with the D lines of sodium and the E line of iron, and on the strength of this it is stated that, "through the obscurity of the carbon bands can be distinctly seen a 'Fraunhofer spectrum'—a spectrum, that is to say, composed, like that of the sun, of dark metallic lines thrown out upon a continuous background. Among the substances originating in them, sodium is certainly, iron probably, recognizable." If the existence of the Fraunhofer lines be admitted, there should be no hesitation in connecting these stars with the solar stars, for a slight but certain carbon absorption is exhibited by the sun, and there would be no need for the subsequent remark (p. 89) that "their spectroscopic isolation leaves us without the means of tracing their relationships." It is more likely that the secondary bands are identical with those in the solar spectrum which are produced by the absorption of our own atmosphere (see Proc. Roy. Soc., vol. xliv. p. 92), and the approach to a planetary condition is thus plainly foreshadowed. This piece of important evidence is not referred to by Miss Clerke, notwithstanding its suggestiveness.

"Gaseous Stars and Nebulæ" form the subject of chapter v., the idea being to continue the succession from Sirian and solar stars, through the red stars and bright-line stars to nebulæ. If the stars of the fourth type and those like Rigel be omitted, this may be taken as the probable sequence of events. The nebulæ are closely connected with the bright-line stars, these, again, with the stars of the third type—the bright hydrogen lines here showing similarity of constitution; stars of the third type merge insensibly into stars like Aldebaran and α Cygni, and, finally, into stars like Sirius.

So far so good; but the author is inconsistent. The Orion stars had previously been grouped with those of the first type, but on p. 72 we find it stated that "the brilliant stars of Orion may be said to mark the first stage on the road to nebulosity." We first find nebulæ placed at one end of the series and then at the other.

Opinions are still divided as to the interpretation of the spectra of "gaseous stars," but these bodies can certainly no longer be regarded as suns; they are similar in structure to the nebulæ, whatever that may be. There are some nebulæ which appear as little more than points of light, and we have Prof. Pickering's word that their photographic spectra strongly resemble those of the bright-line stars. Visually, their spectra are identical with those of such widely-diffused masses as the Great Nebula in Orion. A more perfect sequence of spectra from nebulæ to stars like Sirius could not be wished for.

"Sidereal Evolution" forms the subject of chapter vi. Nebulæ were formerly regarded as quite "distinct and of another order from the group of cosmical bodies to which our sun and the fixed stars belong"; but now we can agree with Miss Clerke in accepting the view that they gradually "merge into unmistakable suns" (p. 84).

"But when we come to the various classes of stars, the order of their succession is less easily determined. The earliest and most obvious idea on the subject was based on a false analogy between the colours of the stars and the colours of glowing terrestrial solids. Red stars, it

was thought, should be regarded, because they had cooled from a condition of white heat, as older than white stars. The colours of stars, however, depend primarily upon the quality and extent of their absorbing atmospheres, and quite secondarily upon their stage of incandescence" (p. 85).

Surely the quality of the absorbing atmosphere must also depend upon the stage of incandescence, and colour may therefore still serve as a guide to the temperature and age of the stars. That the red stars of the third type are young may readily be granted from the evidence previously referred to; but, at the same time, it must be allowed that their temperature is comparatively low. It is, however, argued that the stars of the fourth type are also at an early stage of growth, but the evidence depending upon their alleged intermittently hazy aspect, indicating enormous atmospheres, is not conclusive on this point. In fact, the authorities quoted (Messrs. Pogson and Peek) have only observed it in *variable* stars of the *third* type. From the fact that there is carbon absorption in the sun, it seems reasonable to suppose that the fourth type stars are at a lower temperature than stars like the sun, and are probably the result of the cooling of such bodies.

The discussion of the sun's status amongst celestial bodies naturally comes here. That it was once a star like Betelgeuse, then like Aldebaran, is granted. But has it passed through the Sirian stage? This involves the question of whether the "solar stars" are divisible into two distinct groups, but our author is not quite clear upon this point. She remarks that "it is scarcely conceivable that a state abolished as an effect of condensation should be restored by its further progress" (p. 91). If there are two groups of "solar stars," one group will include bodies a little more condensed than the stars of the third type, in which perfect photospheres have not been formed, while the other will include bodies formed by the further condensation of such stars as Sirius. The two states would not be identical. We know that the sun has a photosphere, and hence the suggestion that it is a cooling body. Its relation to the stars of the fourth type strengthens the view that the sun has already passed through the Sirian stage and will eventually be a fourth type star. Miss Clerke, however, does not accept this view of the effects of further condensation upon a Sirian star, but suggests another which has not a single fact to support it. It is pointed out that the spectrum of the satellite of Sirius, if it could be observed, might give some clue to the spectrum of a waning body; and she is bold enough to predict that it will prove to be of "an undistinguished character, interrupted neither by bands nor conspicuous dark lines, and feeble, not through effects of absorption, but intrinsically. The same dull uniformity may be expected to belong to the spectra of all stars of impaired splendour" (p. 92). What, then, will be the transition stage, say between Sirius and such a body as that suggested? The broad hydrogen lines could not disappear suddenly, and we know that there are no stars showing fine hydrogen lines alone. In fact, it is especially emphasised (p. 42) that "the conspicuousness of rays due to absorption by ordinary metals in the spectra of white stars varies inversely with that of the hydrogen series." Some solar stars, at least, must therefore represent the stage that will be arrived at by the cooling of such a star as Sirius, and the evidence tends to show that the sun is one of them.

Further, if the spectrum of such a waning star were simply dimly continuous, the absence of an atmosphere would be indicated. We certainly know that the moon has no atmosphere, but it does not shine by light of its own. Even the earth has sufficient atmosphere to give a very definite spectrum of absorption, and this atmospheric absorption must have been much greater when the earth was hotter than at present. Cooling stars are not likely, therefore, to give such spectra as Miss Clerke supposes, for we know that a powerfully absorbing atmosphere remains after the photospheric luminosity has disappeared. The spectrum of such a cool atmosphere would no doubt be a fluted one.

Temporary and variable stars occupy the next two chapters, and some valuable information is brought together in an interesting way. Among the spectroscopic observations of new stars, probably the most important were those of Nova Cygni. The most striking thing here was the increased brilliancy of the chief nebula line as the star faded away. That is to say, as the star cooled, it became a nebula, thus affording very decided evidence that nebulæ are comparatively cool. The dimming of new stars takes place so suddenly that it is certain only small bodies can be in question, and the suggestion has been made that new stars were produced by collisions of meteor-swarms. For collisions of this kind, Miss Clerke substitutes "grazing encounters with nebulous masses revolving in hyperbolic orbits, and overthrowing, by their proximity to the attractive body, a thermal equilibrium already eminently unstable." In the case of Nova Cygni no star had previously been recorded in its place, and it is difficult to conceive that such a grazing of a dark body, supposing one existed, with a moving nebulous mass could produce such a brief "conflagration" as was observed.

The old theories of stellar variation, assuming the existence of immense masses of slags in the photospheres, or that one side of a variable star was brighter than the other, have long been discarded. No single explanation is good for all variables, but there is no difficulty with those of the Algol type. After brief references to the explanations which have been suggested for the red stars, Miss Clerke concludes that "the time has not come to formulate a theory of stellar variability" (p. 125). The only comprehensive one we have as yet—the collision theory—is not considered sufficient by Miss Clerke; but careful consideration will remove the objections made against it. This theory assumes as proved the cometary character of stars of the third type, and suggests that the increase of light at the maximum of a variable of this kind is produced by the collisions at the periastron passage of satellite comets or swarms of meteorites. It is objected (p. 124) that this state of things could not long subsist, as the satellite swarm must inevitably become extended into a ring, with complete effacement of variability. This is certainly true, but we have only to look at the "November swarm" in our own system to understand that the disruption of the satellite comet need not be very speedy. This swarm has been observed now for at least a thousand years, and yet the brilliancy of the showers is apparently not diminished. Mira Ceti is the

only variable of this class which has been observed for a long period, and the observations in this case only extend over three hundred years. On p. 124 we read further:—

"The periodicity of variable stars is, besides, of far too disturbed a kind to be thus accounted for. Systematic stability would assuredly prove incompatible with the enormous irregularities it discloses. The abrupt acceleration or retardation, for example, by a month of the hypothetical attendant swarm of Mira, would be impossible without such a total change in the elements of its circulation as would unmistakably break the continuity of its returns. But there are other objects far more recalcitrant than Mira to this mode of explanation. Take the outbursts of U Geminorum. They are not wholly capricious. There is a certain disorderly order about them by which they are manifestly akin to the changes of the more strictly periodical stars. We cannot relegate them to a class apart and invent a fresh hypothesis to suit them; the collision theory, to be acceptable in the one case, must be capable of meeting the other. But we can scarcely conceive any construction of assumptions by which such an extension of its powers could be effected."

Irregularities such as are here referred to are almost bound to occur if the collision theory be true. A star is not limited to one short-period comet any more than is our sun. There may very well be swarms of various masses travelling round the star in regular orbits, and occasionally a swarm travelling in an open orbit may enter the system. These swarms would so react upon each other and upon the central swarm that irregularities would be the inevitable result. Again, the central swarm might vary locally, like the Andromeda nebula, so that the revolving swarm would not always encounter it under exactly the same conditions. That the intervals between successive maxima and the magnitudes at maxima are not constant does not prove that the actions are not periodic.

In NATURE, vol. xlii. p. 550, there are some interesting examples of the apparently irregular results which might be produced by the integration of two sources of regular light variation. Two or more swarms of regular periods with the occasional advent of one moving in a parabolic or hyperbolic orbit, can be made to explain all the facts relating to this class of variables. In the variables of the fourth type, the same explanation holds good, if we consider the direct luminosity of the cometary swarms to be added to that of a dim condensed central body. Miss Clerke, however, supposes that variability depends upon extensive atmospheres, these being disturbed periodically in some way or other, probably by the tidal action of a satellite, so as to produce the observed fluctuations of light. It is a question whether such an atmospheric disturbance could increase the apparent brightness of a star hundreds of times.

The succeeding eight chapters are mainly descriptive, dealing with colour phenomena, double stars, stellar orbits, star clusters, and the forms of nebulæ. It is only necessary to say of these that they are admirable.

Chapter xix., "The Nature and Changes of Nebulæ," discusses the relations of nebulæ and comets, and nebular variability. Referring to comets and nebulæ, it is stated (p. 286) that "traces of a spectroscopic analogy can indeed be shown to exist; but they are met with only in the secondary elements of each spectrum. The resemblance seems only incidental; the dissimilarity essential." It has, however, previously been pointed out (p. 76) that two faint comets observed by Dr. Huggins in 1866-67, gave spectra identical with that of a faint planetary nebula. This may well be regarded as conclusive spectroscopic evidence of the similarity between comets and nebulæ, but although it is apparently only regarded as of secondary importance, "it does not detract from the closeness of a physical analogy." It seems unphilosophical to rely on telescopic similarity when such conclusive spectroscopic evidence is at hand. We might go further than Miss Clerke, and say that as a comet is usually regarded as a swarm of meteorites the same view must be accepted for nebulæ. The information relating to the views on the temperature of nebulæ is very meagre. Some argue that they are intensely hot, whilst others argue that they are cool bodies not unlike comets. Apparently the only statement on this important subject is that on p. 77, where it is stated they "are not greatly heated." Indeed, the evidence afforded by their cometary relationships and by Nova Cygni is conclusive. Yet, as late as 1889, Dr. Huggins stated his belief that the temperature of nebulæ is very high.

It will thus be seen that, although a good deal of Mr. Lockyer's recent important work is left out of consideration, two of his main propositions are accepted by Miss Clerke; viz. (1) "nebulæ merge into unmistakable suns," and (2) they "are not greatly heated."

The remaining chapters consider the distances of the stars, the motion of the solar system, proper motions, the Milky Way, the "status of the nebulæ," and finally the "construction of the heavens." The two latter really discuss the distribution of stars and nebulæ, and bring together a wonderful amount of information which has hitherto been much dispersed.

In justice to Miss Clerke, it is only fair to add that she has exercised a sound judgment on many problems, and has made many valuable suggestions as to the lines on which future investigations should be proceeded with.

The book is well illustrated throughout, among the illustrations being reproductions of some of Mr. Roberts's marvellous photographs. With the exception of that of the Andromeda nebula, these are highly satisfactory.

In conclusion, we would again express our unqualified admiration of a good deal that the book contains, but we cannot help feeling that its value as a contribution to astronomical literature would have been greater if the author had confined herself to simply giving a trustworthy account of contemporary astronomical researches, and of the views held by competent thinkers. A safe and impartial guide to current thought is still a desideratum.

F.

ACROSS GREENLAND.

The First Crossing of Greenland. By Fridtjof Nansen. Translated from the Norwegian by Hubert M. Gepp. With Maps and numerous Illustrations. Two Vols. (London: Longmans, Green, and Co., 1890.)

THE only serious fault to be found with this book is that it is much too long. Only a small proportion of it is devoted to the actual crossing of Greenland, the rest being occupied with matters which might have been,

and ought to have been, dealt with concisely. So far as it relates directly to the author's experience, the work is one of the deepest interest. Dr. Nansen is not only an explorer of remarkable courage, resource, and foresight; he has also many of the qualities of a man of letters. He knows exactly on what parts of his story emphasis should be laid, and his skill as a writer is so great that even incidents which do not in themselves seem to be either very striking or very suggestive are made to add to the freshness and vividness of his tale. One of the chief elements of attraction in the book is the more or less unconscious revelation which the author gives of his own character. He has evidently an intense delight in adventure for its own sake, and he writes in such good spirits, with so unaffected a delight in the remembrance of all the difficulties he has overcome, that it is impossible not to follow his record with sympathy and admiration; and every reader will lay down the work with a feeling of sincere regard for a traveller who is at once so hardy, enterprising, and enthusiastic. He has been most fortunate in his translator, who has done his work so well that the narrative reads almost as if it had been originally written in English. The maps and illustrations, too, are unusually good.

In the summer of 1882, when still a very young man, Dr. Nansen spent some months in the northern seas on board the *Viking*, a Norwegian sealer. The ship was caught in the ice off the eastern coast of Greenland, and it was at this time that he first felt a strong desire to investigate the strange, desolate region at which, many times a day, he gazed from the maintop. In the following year the wish was renewed and strengthened when he read of Baron Nordenskiöld's return from the interior of Greenland; but many things came in the way to prevent the fulfilment of his scheme. In 1887 he attempted, through the Norwegian University, to obtain from the Government the means of organizing an expedition; but the Government declined to support the proposal, and one of the newspapers expressed the opinion that "there could be no conceivable reason why the Norwegian people should pay so large a sum as 5000 kr. in order to give a private individual a holiday trip." Herr Augustin Gamél, however, who was already known as an enlightened and generous promoter of Arctic research, offered to provide the necessary funds; and thus Dr. Nansen was enabled at once to make preparations for his contemplated journey. Three of his countrymen—Otto Sverdrup, Oluf Christian Dietrichsen, and Kristian Kristiansen Trana, all of whom were admirably fitted for the work—undertook to accompany him; and he also secured the services of two Lapps—Samuel Johannsen Balto and Ole Nielsen Ravna. The Lapps were of less use than might have been expected; and under a less genial leader they might have become extremely troublesome. Dr. Nansen knew how to appeal to them, and nothing in its way could be better than his description of the devices by which he contrived to inspire them with a little of his own energetic spirit. It may be noted to his credit that he has nothing to say of any of his companions that may not be read with pleasure. He acknowledges frankly and gratefully all that he owed to them in carrying out his bold and hazardous project.

On May 2 the party left Christiania for Leith, whence they started for Iceland; and about a month afterwards they joined the sealer *Jason* at Isafjord, with the owners of which he had come to an agreement that the captain should do his best to put them ashore on the east coast of Greenland. Dr. Nansen has much to say about the voyage to Iceland, about cruising in the ice, about the bladder-nose seal and its capture, and about life on the *Jason;* and some of the facts he records are not without interest. But they are out of place in a work of this kind, which stands in no need of "padding." Even the account of "Ski" and "Skilöbning," by which the chapters on these subjects are preceded, might with advantage have been shortened. Here, however, the author has some excuse for the minuteness of his descriptions, for without "ski" the journey could scarcely have been undertaken, and the subject is one of which he is able to write picturesquely and effectively.

They quitted the *Jason* on July 17, hoping that they might effect a landing without much delay. But for many days they drifted southwards, and sometimes, battling for life among the floes, they could not but feel that success was almost impossible. Dr. Nansen never lost heart, and no part of his story is more stirring than that in which he records the unexpected and perilous adventures encountered at this early stage of his journey. When at last they reached land, they were, he says, "just like children." "A bit of moss, a stalk of grass, to say nothing of a flower, drew out a whole rush of feelings. All was so fresh to us, and the transition was so sudden and complete. The Lapps ran straight up the mountain-side, and for a long while we saw nothing more of them." Dr. Nansen was so relieved and delighted that, when gnats settled on his hand, he "let them sit quietly biting, and took pleasure in their attack." On the same day they embarked again, and pushed on quickly, as it was necessary for them to start from a more northerly position. They landed at their last camping-place on the eastern coast on August 10, and on August 15, after various preliminary arrangements, they set off for the interior, intending that their goal should be Christianshaab. Afterwards Dr. Nansen found it expedient to alter the route, and to make for Godthaab.

Of the journey itself little need be said, as the main facts are already well known, and an adequate conception of the details can be obtained only from the author's fascinating narrative. For some time they had to mount steadily, until they reached a height of 8970 feet. Then they came to a comparatively flat region, beyond which the ice-sheet descended gradually towards the western coast. The difficulties were enormous, for they had to drag their provisions on sledges, and they were repeatedly caught in violent storms, during which they were obliged to remain for shelter in their small tent. The cold was sometimes terrible; their rations were anything but abundant; and they had to sleep in bags. But no obstacles were formidable enough to daunt the leader of the party, and his task was lightened by the fact that he succeeded in maintaining from first to last the most friendly relations with his comrades. Although few incidents of any importance broke the monotony of their progress, Dr. Nansen found much to interest him in such scientific observations as the conditions rendered possible; and even in the interior of Greenland elements of

splendour and beauty were not wanting. The greater part of their travelling was done in the daytime, but at first they thought it best to proceed by night. Here are some of Dr. Nansen's reminiscences of his impressions during their night-marches:—

"But if we often suffered a good deal in the way of work, we had full compensation during these nights in the wonderful features of the sky, for even this tract of the earth has its own beauty. When the ever-changing northern lights filled the heavens to the south with their fairy-like display—a display, perhaps, more brilliant in these regions than elsewhere—our toils and pains were, I think, for the most part, forgotten. Or when the moon rose and set off upon her silent journey through the fields of stars, her rays glittering on the crest of every ridge of ice, and bathing the whole of the dead frozen desert in a flood of silver light, the spirit of peace reigned supreme, and life itself became beauty. I am convinced that these night-marches of ours over the 'inland ice' left a deep and ineffaceable impression upon the minds of all who took part in them."

As they advanced over the ice-sheet, they longed more and more for land; and one afternoon, just two months after they had left the *Jason*, they were enchanted by the sudden appearance of a snow-bunting, from which they knew that the western coast could not be very far off. On September 19, Balto caught sight of a black spot in the distance, and immediately afterwards all of them were able to make out, through the mist of snow, "a long, dark mountain ridge, and to the south of it a smaller peak." On September 24, Dr. Nansen found himself "on the brow of an ice-slope which overlooked a beautiful mountain tarn, the surface of which was covered with a sheet of ice"; and shortly afterwards they had the pleasure of walking on solid ground. He says:—

"Words cannot describe what it was for us only to have the earth and stones again beneath our feet, or the thrill that went through us as we felt the elastic heather on which we trod, and smelt the fragrant scent of grass and moss. Behind us lay the 'inland ice,' its cold, grey slope sinking slowly towards the lake; before us lay the genial land. Away down the valley we could see headland beyond headland, covering and overlapping each other as far as the eye could reach."

On October 3, Dr. Nansen and Sverdrup reached Godthaab, where they were soon joined by their companions. For a moment it was unpleasant for them to find that they would have to spend the winter at this remote station; but they met with so much kindness that their stay proved to be in every way more agreeable than they anticipated.

Of the scientific results of the expedition, the most important is the establishment of the fact that the ice-sheet stretches in unbroken continuity over that part of Greenland which the party traversed. How far the ice-sheet extends towards the north we do not yet know; but Dr. Nansen concludes that "its limit must lie beyond the 75th parallel, for so far along the west coast it sends huge glacier-arms into the sea. Among these is Upernivik Glacier, in lat. 73° N., which has a rate of advance of no less than 99 feet in the twenty-four hours. So rapid a movement must presuppose the existence of an enormous interior ice-sheet, which can supply material for consumption on this huge scale." An idea of the form and elevation of the ice-sheet is conveyed by a section or profile drawing, constructed by Prof. Mohn and Dr. Nansen from numerous astronomical and barometrical observations, supplemented by the notes of Dr. Nansen's diary. This section shows that "the ice-sheet rises comparatively abruptly from the sea on both sides, but more especially on the east coast, while its central portion is tolerably flat. On the whole, the gradient decreases the further one gets into the interior, and the mass thus presents the form of a shield with a surface corrugated by gentle, almost imperceptible, undulations lying more or less north and south, and with its highest point not placed symmetrically, but very decidedly nearer the east coast than the west." Dr. Nansen indulges in some speculations as to the action of "great ice-sheets," but here his work is less satisfactory than in those passages in which he simply sets down what he himself has seen. Speaking of the fact that glaciers are stated by geologists to "have carried huge moraines of boulders and grit upon their backs," he says that to his mind "this idea is nothing less than absurd"; which is surely an odd way of talking about a conclusion based on a wide range of careful and exact observations. Dr. Nansen serves science more effectually in presenting facts as to temperature, snow- and rain-fall, and atmospheric pressure, and in describing the daily life of the Eskimo, some of whom he met on the eastern as well as on the western coast.

Dr. Nansen is now making preparations for a Polar expedition, which he proposes to undertake in 1892. If we may judge from his achievements in Greenland, he possesses in no common degree the special talents which are necessary for any measure of success in this larger and more difficult enterprise. No one who reads his book will hesitate to acknowledge that he has shown himself one of the ablest and most daring explorers of the present generation.

OUR BOOK SHELF.

Les Microbes de la Bouche. Par le Dr. Th. David. (Paris: Felix Alcan, 1890.)

THIS book will be found of considerable value. Although Dr. David does not record original observations of his own, most facts stated being copied from other works, he nevertheless deserves credit for putting together in concise form all that is known of the micro-organisms occurring in the oral cavity, on and in the organs of the mouth in health and disease. The morphology, cultural and physiological characters of most of these microbes are described in detail, including those of diphtheria, tubercle, and actinomycosis. From p. 205 to p. 262 the author gives a valuable account of the bacteria present in diseased teeth, but unfortunately he adds—probably for purposes of the professional dentist—a number of prescriptions on cosmetics, tooth powders, &c., which ought not to find a place in a scientific work of the character of the present book. The appendix on influenza might well have been omitted.

Notes on the Products of Western Afghanistan and North-Eastern Persia. By J. E. T. Aitchison, C.I.E., M.D., F.R.S. Pp. 228. (Edinburgh: Neill and Co., 1890.)

A REPRINT from the Transactions of the Botanical Society of Edinburgh, containing an alphabetical synopsis of the animal, vegetable, and mineral products of Western Afghanistan and Eastern Persia, together with their native names, with their English and Latin equivalents, and their applications. Dr. Aitchison's contributions to the botany and zoology of Afghanistan and

the adjoining countries are well known to specialists, and the present work is an amplification of the economic branch of his investigations. Persia has been specially noted from time immemorial for its drugs, dyes, perfumes, and other vegetable productions, but much yet remains to be done in the elucidation of the plants which yield them. Dr. Aitchison was attached to the last military expedition to Afghanistan, and he was also naturalist to the "Delimitation Commission," and made very extensive collections of botanical and zoological objects, especially of the former. During the latter expedition he specially investigated the origin of the drugs, such as the asafœtida, obtained from umbelliferous plants, and the main results are given in a handsomely illustrated memoir that appeared in the Transactions of the Linnean Society.

The "Notes" now offered to the public afford another proof of the immense energy and perseverance of the author in collecting materials and information, often under great difficulties; and they will be welcomed by all interested in the subject. As the author informs us in some prefatory remarks, he has brought these notes together as a guide to future workers, having himself greatly felt the want of some such aid.

We believe that Dr. Aitchison contemplates another journey to Persia in order to extend his researches into the products of the country. W. B. H.

Metal-Turning. By a Foreman Pattern Maker. (London: Whittaker and Co., 1890.)

THIS book is written to explain and illustrate the practice of plain hand turning, and slide-rest turning as performed in engineers' workshops. The ornamental section of the craft is therefore entirely excluded. No attempt is made to describe all the numerous types of heavy lathes which are to be found in large workshops. The author tells us this in the preface, his object evidently being to treat the subject thoroughly from the works point of view, and not from that of the amateur manufacturer of ivory boxes and the like. The section on tools and tool angles is excellent, and will repay careful reading by turners; many, who are in all other respects good workmen, often make a fearful hash when grinding their tools.

When the much-abused "practical man" is induced to give his experience to the world in the form of a book, there is generally something worth reading and remembering to be found. This is the case in the work before us, which can be well recommended to all interested in its subject-matter. N. J. L.

The Century Arithmetic (*complete*.) (London: Blackie and Son, Limited, 1890.)

IN glancing through the pages of this volume, we are struck by the immense number of examples that are inserted; in fact, the work consists of practically nothing more than a series of exercises, commencing with simple addition and concluding with stocks. They have been arranged in an easy and progressive manner, and at the beginning of each new series of examples a typical case is worked out fully, and at the conclusion are mental tests which are given by inspectors. Intended as they are for Board schools and the like, the exercises should be found most instructive, for the subject can be grasped best by the constant working out of examples such as those that are here so copiously brought together.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Biological Terminology.

IN a recent number of NATURE (December 11, p. 141), Prof. T. J. Parker gives three suggestions in biological terminology, on which you will perhaps permit me to make one or two remarks, as his notes are *à propos* of some criticisms of mine on his paper on that subject (Proc. Austr. Assoc. Adv. Sc., vol. i., 1888).

(1) The term *agamobium* for the asexual generation in plants and animals, as suggested by Prof. Parker, certainly escapes the objection I raised to the term *blastobium*. I am not sure, however, that botanists, even though they might agree with Prof. Parker's general views on terminology, would be inclined to designate as an *agamobium* both the asexual state of a *Vaucheria* (for example) and the asexual generation of a fern. Prof. Bower in a recent paper (*Ann. Bot.*, vol. iv. No. 15) has drawn attention to the distinction made by Celakovsky between homologous and antithetic alternation of generations. The important differences between those two types of alternation would, I think, be in danger of being once more lost sight of if the asexual stages both of the homologous and of the antithetic type were known by the same name.

(2) My objection to Prof. Parker's use of the anglicized form of *ovarium* (ovary) would disappear, if "ovary," in its ordinary acceptation in botany, could be got rid of altogether, "ovule" of course following in its train. Megasporangium (for "ovule") is now generally in use, and it is possible that in time "ovary" may give place to some more suitable term, which will express the true morphological value of the structure known as the "ovary." For uniformity's sake one might wish to see either classical names or their English equivalents used throughout, and since we have already adopted *megasporangium*, *microsporangium*, *ovum*, *sperm* (or *spermatozoon*), &c., and may adopt *gamobium* and *agamobium* (for which there are no English equivalents), the balance seems to turn distinctly in favour of the classical as opposed to the English names.

(3) Prof. Parker advocates the use of special terms for certain "important stages in plant development." All botanists will, I think, accept—at least in time—the term *oosperm* in place of "oospore." That this term ought to be applied to the *unicellular* embryo only there can be no question. Prof. Parker objects to the use of *oosperm* (in Haddon's "Embryology") to indicate the advanced mammalian embryo. I unite with him in his protest, but might add that *oosperm* as applied to an advanced embryo is far preferable to the term *ovum* for the same structure (McKendrick, "Text-book of Physiology," vol. ii. p. 746). In Quain's "Anatomy," for instance, such phrases as "in an ovum of from five to six weeks" (vol. ii. p. 765, 9th ed.) are of frequent occurrence. Whether names *are* required for successive stages in plant development is perhaps an open question. At all events, I cannot see that Prof. Parker is justified in applying the term *polyplast* to the fully formed sporogonium of a moss. A body with the histological differentiation observable in the sporogonium of *Polytrichum* or even of *Jungermannia*, cannot surely be designated by the same term as that applied to the body to which Haeckel gave the name of *morula*. If "highly differentiated," surely it has ceased to be a *polyplast*. Personally, I would feel inclined to use the general term *embryo* for all stages of development after segmentation has begun.

R. J. HARVEY GIBSON.

Botanical Laboratory, University College, Liverpool.

Streamers of White Vapour.

I STAND this morning in my private room in the University building, looking out over the harbour, and away to the open expanse of Lake Ontario. The shore is to the south of me, and runs east and west. The wind is blowing from the north, and hence from the land over the water. The temperature of the air is about 3° or 4° F., and the temperature of the water is about 45° F.

The whole surface of the water, as far out as the eye can distinguish, is covered with a perfectly white mist like a lowlying fog, so that the appearance of steamers on the bay is that of vessels drifting through a cloud bank, but with the higher upper works and the smoke-stacks mostly elevated above the cloud.

The most peculiar phenomena, however, are the streamers of white vapour which rise in straight or spiral columns, very limited in breadth, but reaching to a great height. These may be seen by hundreds, some rising to a greater height, some to a less, although from the large extent of surface under view, the more prominent ones cannot be very near together. I have watched these streamers from year to year with great interest,

for they always present themselves at the first appearance of very cold weather at the coming on of winter, and before the surface of such an immense body of water has had time to cool down after the summer heats.

You will see one of these streamers start up from its apparent bed of cloud, and, with a sort of wriggling, twisting motion, make its way upwards to a great height in a very few seconds, and drift slowly along with the wind, like a spindling but giant column of steam. They, in the meantime, undergo a slow but incessant change, and sometimes they gradually vanish at the top while being renewed from below, while at others they detach themselves at the base and float heavenward until they vanish in mid air or lose themselves in the overhanging and distant cloud.

The whole phenomenon reminds me very forcibly of the pictures of the solar streamers which are to be seen in various illustrated works on the sun, and the two are probably brought about by somewhat similar causes, although the difference in the degree of action must be almost infinite.

I have no means of determining the heights of these streamers except approximately. There is, however, a wooded island about one half a mile wide, and the distant shore of which is about five miles from the city. It is a common thing, under favourable circumstances, to see the streamers rise from the further side of that island to a height of from ten to twelve times the height of the tallest trees on the island, which would give a height of at least about 500 feet; and as the base of these streamers may be at some distance beyond the island, their height may occasionally be considerably above this estimate.

The continual shooting upwards of these, and their continual motion and change, offers a phenomenon at once very interesting and very beautiful. I have never seen the appearance at its best to last above five or six hours, and any second appearance is always inferior to the first. I may add that the same scene presents occasionally, in the spring, some of the finest mirages to be seen anywhere. N. F. DUPUIS.

Queen's College, Kingston, Canada, December 2.

On the Affinities of Hesperornis.

AMONG some very useful and important papers recently issued by the Museum of Zoology of the University College, Dundee, appears one by Prof. D'Arcy Thompson, "On the Systematic Position of *Hesperornis*." In this excellent scientific brochure, Prof. Thompson has critically compared in detail the skeleton of a diver (*Colymbus septentrionalis*) with the skeleton of *Hesperornis*, as presented us by Marsh; and the outcome of this investigation has fully convinced the author of the work in question of the kinship, which undoubtedly exists, between the extinct *Hesperornis* and the existing pogopodine birds, as the divers, loons, and grebes. We have long been satisfied of these affinities, and firmly believed that the *Colymbidæ* were the descendants, perhaps direct descendants, of the toothed birds of the genus *Hesperornis*. It required but such comparison as has been so ably instituted by Prof. Thompson to make it quite clear to any thoughtful anatomist; and, as he hints, a similar comparison will probably go to show the fact that another extinct toothed bird-form, *Ichthyornis*, lies in the line of descent of the terns and their allies.

It is said by those who are opposed to these opinions that the agreement in skeletal characters between two such forms as *Hesperornis* and *Colymbus* are but superficial, and due to the fact that the birds did have in the case of the first, and now have in the case of the divers, similar habits.

The advocacy and adoption of such a view as this could but tend to mask their real affinities, impede the solution of the natural taxonomy of extinct avian forms, and be dangerous to the proper use of osteological characters in the premises. Hardly would "similarity of habits" produce morphological likenesses in such bones as the vomer, the pterygoids, the occipitals and the condyle they form, and a number of others which practically agree in *Hesperornis* and the *Colymbidæ*, and are very different in the *Ratitæ*.

So far as such a bone as the sternum is concerned, the fact whether it be "keeled" or "not keeled" must be used with no little caution when we come to decide upon the affinities of bird-forms, be they extinct or otherwise. And were the fossil remains of birds, which formerly existed upon the earth, in our possession in sufficient number and variety, I am quite sure that true avian kinships could not be established upon any such hard and fast lines as to whether or no their sterna were "carinated" or "non-carinated." We would undoubtedly meet with ostrich-types that could fly, and so have keeled sterna; and also ratite-types that enjoyed not such volant powers, and consequently possessed the "raft-sternum," as did *Hesperornis*, our great extinct ancient diver, which, as we know, was flightless, raft-sternumed, but withal, in the remainder of its skeleton, presenting all the fundamental characters of the now-existing Pygopodes, especially in so far as they are represented by the grebes and loons. R. W. SHUFELDT.

Takoma, D.C., December 5.

A Swallow's Terrace.

IN your issue of November 27, Mr. Warde Fowler gives a description of an unusually straggling nest of the swallow. An example to the contrary, of extreme neatness, which came under my notice a year or two ago, and which I still preserve, is the following:—My brother, on entering an old cottage in Somersetshire which had been empty for a long time, found in one of the rooms a lath, broken at one end, depending from the ceiling at an angle of about 30°. The lath was about 18 inches long, and on the free end was a swallow's nest containing four very handsome eggs, heavily marked with large blotches of purple-brown. The nest was perfectly circular and shallow, like a tea-saucer, its external dimensions being about 5 inches diameter by 2 inches deep. It was built of the usual materials, the exterior being of mud, with which it was secured to the lath, and the lining of hay with an inner lining of feathers. Close by were other swallows' nests, just inside the top of a chimney and quite open to the sky, so that a covered site does not seem indispensable if the nest be sufficiently sheltered. In view of this and the preceding description of nest with its fragile support, it would not appear surprising to hear of a swallow building on the branch of a tree provided it were in a well sheltered situation. ROBERT H. READ.

Cathcart, Glasgow, December 17.

Nests of the Red-backed Shrike.

WHILST writing on the subject of nests, I would like to remark that I examined three nests of the red-backed shrike this last summer, and that the colour of the linings appear to bear out the remarks of a correspondent which appeared in NATURE some months ago. Two of the nests contained eggs of a pale pink ground-colour, whilst the eggs in the third were of a creamy-white ground-colour. In the third nest the lining was of roots, a few black horsehairs, red and white cowhair and a little wool. In the first two nests there was no white hair or wool, the lining consisting chiefly of roots and red cowhair. Although this seems to corroborate the experience of your correspondent, yet the difference in ground-colour of the three sets of eggs was so comparatively slight that I would not like to infer from these three nests alone that the colour of the nest-lining had any significance from a protective point of view.

Cathcart, Glasgow, December 17. ROBERT H. READ.

"Fire-ball" Meteor of December 14.

IT will probably be of interest to many besides your two correspondents—whose letters are respectively dated from Sittingbourne in Kent, and Loughton in Essex—to learn that the remarkable meteor they describe was also observed about the time mentioned by them (9.45) in this neighbourhood.

Dr. Dixey, of Finchley, described it to me on the following day (Monday), remarking that "it would be sure to be in the papers"; and, moreover, the staircase of this house was brightly lit up, through the skylight above it, also at 9.45, I observing to my wife, who came to tell me of it, that the light probably came from a large meteor. My friend Dr. Dixey told me that he did not notice any trail. JAMES TURLE.

North Finchley, Middlesex, December 18.

THE FOSSIL MAMMALS OF NORTH AMERICA.[1]

THIS important contribution to our knowledge of the extinct mammals of the United States is the joint production of Profs. W. B. Scott and H. F. Osborn, of the Geological Museum at Princeton College, to whom we are already indebted for much valuable work on the subject. The present memoir is of more than ordinary importance, since the authors have endeavoured to complete our knowledge of forms already more or less fully described, rather than to add fresh burdens to the memory by recording a host of so-called new species and genera founded upon specimens which are not sufficiently characteristic to prove their distinctness from forms already described. Indeed, they have taken the opposite course, and endeavoured to show how the number of such species and genera may be reduced; not shrinking, as the manner of some is, from relegating when necessary some of the terms proposed by themselves to the rank of synonyms. This line of work, we are assured, is the one now urgently called for, as it is almost certain that the number of names which have been already proposed must, if properly defined and correlated, really include by far the greater proportion of the animals of the better known formations.

The work is divided into four parts; the first and second being by Prof. Scott, the third and fourth by Prof. Osborn. Part I. treats of the geological and faunal relationships of the Uinta beds; Part II. includes those mammals referable to the groups known as Creodonts, Rodents, and Artiodactyle Ungulates; Part III. is devoted to the Perissodactyle Ungulates; while the concluding Part is an endeavour to trace the gradual modification of the foot-structure of the Ungulates from the generalized older forms to the specialized types found at the present day.

In the first part we are told that in the Upper Green River valley in Colorado there are three well-marked groups of Tertiary strata overlying the Upper Cretaceous Laramie beds, and named, in ascending order, the Wasatch, Green River, and Bridger Eocene groups; the earliest Puerco Eocene being apparently missing between the Laramie and the Wasatch beds. The Bridger, or Middle Eocene, which is further divisible into three minor groups, is characterized as a whole by the presence of the now well-known Dinocerata, so fully described by Profs. Marsh and Cope. The geology of the Uinta beds and their relation to the Bridger group appear to be somewhat obscure; but it seems that while part of these beds may be contemporaneous with the Bridger, the greater portion is decidedly newer, and consequently that the entire group should be classed as Upper Eocene, and regarded as forming the transition to the Miocene beds of the White River. These Uinta beds are readily distinguished from the Bridger group by the absence of the remains of Dinocerata; and their fauna of Perissodactyle Ungulates is described as being intermediate between that of the Bridger Eocene and the White River Miocene. The genera of mammals which the authors record from these beds include (1) *Mesonyx* and (2) *Miacis* among the Carnivorous types, (3) the Rodent *Plesiarctomys*, (4) the Lemuroid *Hyopsodus*, in the Artiodactyle Ungulates (5) *Protoreodon*, and (6) *Leptotragulus*, and in the Perissodactyles (7) *Diplacodon*, (8) *Isectolophus*, (9) *Triplopus*, (10) *Pachynolophus*,[2] and (11) *Amynodon*. Of these genera, Nos. 5, 6, and 7 are peculiar to the Uinta beds, while all the others are represented in the underlying Bridger group.

Of the forms described in Parts II. and III., we shall merely notice a few of those which are of more especial interest. The first of these is the Rodent genus *Plesiarctomys*, first described by Bravard upon the evidence of very fragmentary remains from the European Tertiaries, but now fully known through the specimens described in this memoir. Dr. Scott regards this form as one of, if not actually the oldest of the known Rodents, and as therefore entitled to especial interest from an evolutionary point of view. He finds that the molar teeth (Fig. 1) are of the tritubercular type so characteristic of the earlier

FIG. 1.—The left upper and lower cheek-teeth of *Plesiarctomys sciuroides*.

Eocene mammals of all orders (see NATURE, vol. xli. p. 465), and therefore concludes that the Rodents were probably derived from the same generalized group of mammals which has given origin to the existing Carnivora and Ungulata. *Plesiarctomys* itself should apparently be placed among the existing Sciuromorpha (squirrels and marmots), although in certain generalized features of the skull it shows signs of affinity with the Hystricomorpha (porcupines).

Another form of considerable interest is the genus *Leptotragulus*, a small Ungulate at first regarded as allied to the existing chevrotains (Tragulina), but which proves to be the earliest definitely known ancestral type of the camels and llamas (Tylopoda). This genus is indeed now regarded as the direct ancestor of *Poëbrotherium* of the overlying White River Miocene, the latter being an early cameloid type not larger than a fox; and thus affords another example of the rule that all groups of mammals increase in the size of their representatives with the advance of time. Other observations induce the author to suggest that these early Cameloid types may themselves have originally branched off from the little *Dichobunus* of the Eocene of Europe and probably also of America—a small chevrotain-like Ungulate, with bunodont molars carrying five cusps on their crowns. If this full phylogeny be substantiated by later researches it will be of extreme interest.

The Artiodactyle Ungulate described as *Protoreodon* is another annectant genus of more than ordinary interest. Thus while it conforms to the Miocene Oreodonts in the structure of the feet, and in the peculiar feature that the first lower premolar assumes the form and functions of a canine, its upper molar teeth differ in that they have five instead of four cusps on the crown, and thus accord with those of the generalized hog-like Ungulates known as *Anthracotherium* and *Hyopotamus*. This is a very important fact pointing very strongly to the derivation of the Oreodonts from an early stock more or less closely allied to the known *Anthracotheriidæ*.

With the Perissodactyla we come to the work of Prof. Osborn, and some important observations are made, in the introductory portion of Part III., regarding the synonymy of some of the earlier forms of the ancestors of the horse. It is there stated that Prof. Marsh's genus *Eohippus* is identical with Owen's *Hyracotherium* of the London Clay, from which *Pliolophus* appears to be likewise inseparable. The distinctive feature of this genus is that the fourth premolar in both jaws is unlike the first molar, the fourth upper premolar having but a single inner cusp. *Orohippus*, however, which has been hitherto identified with *Hyracotherium*, is shown to be distinct, the fourth premolar being as complex as the true molars; this genus is, however, identical with the European *Pachynolophus*. *Epihippus*, in which both the third and fourth premolars become like the molars, forms the next step in the ancestry of the horse, leading on to the well-known European genera

[1] "The Mammalia of the Uinta Formation." By W. B. Scott and H. F. Osborn. Transactions of the American Philosophical Society, Ser. 2, Vol. XVI., Part III. Pp. 111, plates 5, and woodcuts. (Philadelphia, 1889.)

[2] Incorrectly *Orotherium* in the text.

Anchilophus and *Anchitherium*. An interesting section is devoted to the rhinoceros-like animals described under the names of *Amynodon* and *Metamynodon*, the latter occurring in the White River Miocene. These genera are regarded as representing a distinct family, distinguished from the living rhinoceroses, among other features, by the resemblance of the last upper molar to the two preceding teeth. We are scarcely disposed to regard this and the other features mentioned as of sufficient importance to justify the formation of a distinct family, but this is purely a matter of opinion. *Amynodon* has been generally regarded as the ancestor of the modern rhinoceroses, but Prof. Osborn points out several objections to this view, and also shows that *Metamynodon* is clearly a separate branch from *Amynodon*, departing still more widely from the modern rhinoceroses. It is suggested, however, that the real ancestor of the latter will prove to be more or less closely allied to *Amynodon*.

Of the other Perissodactyles described in the third part, it will suffice to mention that *Isectolophus* is regarded

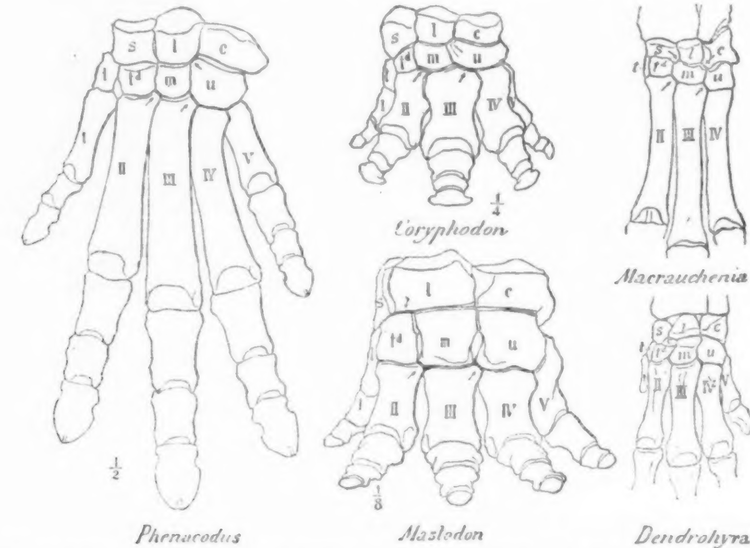


FIG. 2.—The left fore-foot of various Ungulates, to show the more generalized condition, in which the scaphoid (*s*), lunar (*l*), and cuneiform (*c*), are respectively placed directly over the trapezoid (*td*), magnum (*m*), and unciform (*u*). In *Mastodon* the lunar has extended over the trapezoid. *t* = trapezium.

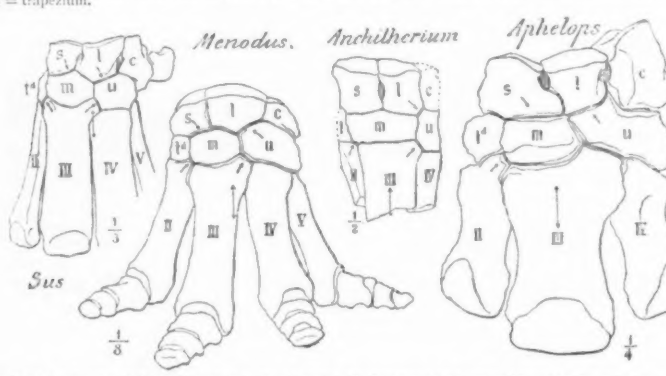


FIG. 3.—The left fore-foot of more specialized Ungulates, showing the displacement and mutual interlocking of the carpal bones. Letters as in Fig. 2. The vertical arrows indicate the median line of the foot, and the oblique ones the direction of displacement.

as an ancestral type of the tapirs, in which the fourth, and probably the third, upper premolar approximated to the type of the molars. The author considers that an imperfectly known tapiroid from the White River Miocene will prove to have three upper premolars of a molariform type, and would thus lead on closely to the true tapirs, in which all the premolars are molariform.

These observations show that in each of the three existing families of Perissodactyles there is a gradual advance in the complexity of the premolars, till in all the living types they become as complex as the molars.

In the concluding part, relating to the advance from a plantigrade and pentadactylate type of foot in the Ungulate to the digitigrade type with a reduced number of digits, Prof. Osborn lays great stress on the effects of strain and impact as leading to the gradual displacement and thence abortion of the lateral elements in the wrist, ankle, hand, and foot, supporting his conclusions with several diagrammatic figures, of which we reproduce two. The author observes that the feet of the modern Ungulates are connected with the simple type of foot found in the Ungulates of the Puerco Eocene by the

genus *Phenacodus*, and that without this annectant form it would have been almost impossible to say that the Puerco mammals were Ungulates at all, since their feet are more like those of the plantigrade Carnivores. The details of how the foot of the generalized primitive type has become gradually modified into the numerous modifications exhibited by the Ungulates of the present day, are far too technical and complicated to be even touched upon in these pages, and we must therefore refer the reader desirous of entering upon this difficult branch of study to the memoir itself. We may, however, mention that the primitive type of foot (Fig. 2) is characterized by the component bones of the two horizontal rows of the wrist and ankle being placed vertically one above another, over the axes of the digits they respectively support; while in the specialized types (Fig. 3) these bones mutually overlap and interlock, so as to totally obliterate the original vertical lines of division coinciding with the intervals between the individual digits. The nearest approach to the primitive type now remaining, is found in the elephant and the hyrax; but the elephant and its ally the mastodon (Fig. 2) are peculiar in that the lunar bone of the wrist has become extended towards the outer side so as to rest upon the trapezoid.

In conclusion, we may observe that a memoir like the present marks a distinct advance in our knowledge, not only of the mammals of the Upper Eocene of North America, but also in respect to several points in connection with the phylogeny of the Ungulates, and of the relationship of the extinct Old World representatives of that order to those of the new. We offer our congratulations to the authors, and look forward to seeing equally good work on the mammals of other horizons of the Tertiaries of the United States. R. L.

EARTHWORMS.

THE Colonial Office can hardly render a greater assistance to science, than by publishing such reports from our distant possessions as that contained in the October number of the *Kew Bulletin*, from Mr. Alvan Millson, Assistant Colonial Secretary at Lagos, who has also acted as a Special Commissioner to the interior, and who has made good use of his opportunities in observing Nature in those remote parts.

The report in question is contained in a despatch from Sir Alfred Maloney to Lord Knutsford, dated June 11, 1890, and we propose to give a short account of its contents.

In Yoruba Land, after passing the fringe of forest, which skirts the lagoons to the eastward of Lagos for some 50 miles inland, a vast tract of open country is reached, extending as far as the valley of the Niger and the Houssa States beyond. The only difference between these grass lands and the forest fringing the lagoons appears to be that "for many generations the farmers of Yoruba have with axe and fire destroyed the growing trees, and robbed the soil of its original covering, leaving nothing but a rank growth of tall and tangled grass to take its place." This is apparently unfavourable to the growth of deep-rooting trees, but shows a truly surprising surface-fertility, when subjected to cultivation; and as the Yoruba people are cut off from the coast by the tribes inhabiting the forest belt, and are entirely dependent on the soil for food and clothing, it has to support a considerable population.

The soil appears to consist of a sandy loam derived from the igneous rocks, ironstone or quartz conglomerate, which form the bed rock, the soil increasing in fertility where the harder strata give place to more friable micaceous rocks, but even where the soil is not over a foot in depth, the fertility is truly astonishing. Crops in Yoruba are not only of unusual excellence, but the surface soil shows a marvellous recuperative power, even when compared with that of favoured lands in other portions of the tropics.

In this district, after a very simple tillage with the hoe only, the following rotation of crops is raised. In the first year a crop of yams and Indian corn is planted, and a second crop of maize and beans in the autumn; the same in the second year; while in the third year both crops are maize and beans. No manure of any kind is used, nor any tool more powerful than the hoe; and then for two or three years the land lies fallow, after which it is ready for a similar rotation, and so on. A crop of Guinea corn, cotton, indigo, tobacco, and sweet potatoes is also in some places gathered.

In spite of the exhaustive system of cultivation pursued, the crops show no sign of falling off, and such is the inexhaustible fertility of this belt, that maize sells for 4½*d.* and sweet potatoes at 1*d.* per 70 pound load, and other products in proportion, even in large towns like Ibadau, said to have 150,000 inhabitants.

Mr. Millson considers that the fertility cannot be caused by termites, as described by Drummond in "Tropical Africa," as the ant-hills of the Yoruba land are exceptionally small and widely scattered; and visiting the country only in the wet season, it would appear impossible to account for the unusual fertility. In the dry season the mystery is at once solved, in a very simple and, Mr. Millson considers, in a most unexpected manner; although, taking into account the universal presence of the earthworm, both in temperate and tropical climates, we think there is little reason for surprise; but we do not remember to have heard of a more marked instance of the importance of small agencies in effecting great results.

Mr. Millson continues:—"The whole surface of the ground, among the grass, is seen to be covered by serried ranks of cylindrical worm-casts, varying from a quarter of an inch to 3 inches, and existing in astonishing numbers. For scores of miles they cover the land, closely packed, upright, and burnt by the sun into rigid rolls of hardened clay, which stand until the rain breaks them down into a fine powder. . . . On digging down, the soil is found to be drilled in all directions by countless multitudes of worm-drills; while from 13 inches to 2 feet in depth the worms are found in great numbers in the moist subsoil."

Mr. Millson estimates that the worm-casts, in one season, average over 5 pounds per square foot of soil; and at this estimate, which he considers very moderate, the annual result of the work done by the earthworms of Yoruba gives a total of not less than 62,233 tons of subsoil brought to the surface in each square mile of cultivated land every year. "This work goes on unceasingly year after year, and to the untiring labours of its earthworms this part of West Africa owes the livelihood of its people. Where the worms do not work, the Yoruba knows that it is useless to make his farm."

Mr. Millson estimates that every particle of earth in each ton of soil, to the depth of 2 feet, is brought to the surface once in twenty-seven years, which gives an average of 0·88 inch per annum, or four times as much as Darwin estimated ("Earthworms," p. 130) to be the case in the experiments tried at Maer Hall; but on the Nilgiries, worm-casts are found to average 3 ounces each, the largest weighing 4¼ ounces (*ibid.*, p. 129). We have, therefore, little doubt that Mr. Millson's estimate of the movement of soil is quite probable.

Mr. Millson considers that, most probably, the comparative freedom of this part of West Africa from dangerous malarial fevers is due, in part at least, to the work of the earthworms in ventilating and constantly bringing to the surface the soil in which the malarial germs live and breed. Darwin (*ibid.*, p. 239) remarked that the disappearance of organic matter from mould was probably much aided by its being brought again and again to the surface in

the castings of worms, and this would account for the absence of malarial fevers.

The worms sent home by Mr. Millson have been submitted to Mr. F. E. Beddard, who reports that they belong to a probably new species of the genus *Siphonogaster*.

We trust that Mr. Millson will continue to send home further accounts of his valuable observations, and that the example he has set will be followed by others stationed in our colonies. S. N. C.

MUSEUMS FOR PUBLIC SCHOOLS.

ALL teachers, I have no doubt, have experienced the refreshing interest that boys and girls take in objects of natural history. And not in natural history merely, for whenever the lesson, no matter what it is about, admits of being illustrated by specimens, then the presence of these specimens gives a point to the description and produces an effect that otherwise would be wanting. Take your young audience in imagination into the country or to the seaside, and show the nest and bird, insect, plant, seaweed, or crab you are describing, and you know you can sustain their attention throughout. It is equally certain, too, that, in describing the characteristics of any particular place, it is desirable to be able to indicate by something more than the bare statement what is meant by "solan-geese and other sea-fowl," and such expressions. How vague often are the ideas produced by the words ruby, marble, granite, isinglass, and other "articles of produce," even though well described, when the actual article itself is bound to implant the nature of the object in the pupil's mind, and the description at the same time. How much could be taught in a very agreeable way, moreover, with a series of specimens exhibiting the manufacture of certain important fabrics from the raw material, and especially those that are made in the immediate district of the school.

It will be generally admitted, I think, that schools should be provided with the means of giving such instruction: the difficulty is, how can it be done? Suggestions have been made on several occasions that the specimens in our public museums should be made available for the purpose. Dr. James Colville, in a paper on "Public Museums as Aids in Teaching,"[1] has pointed out that he is allowed to draw upon the Glasgow Museum for specimens. In Liverpool, alone, however, as far as I know, is the circulation of museum objects carried out in a satisfactory and systematic manner. A good account of the method is given in a pamphlet on a "Proposed Circulating Museum for Schools and other Educational Purposes," by the Rev. Henry H. Higgins, published in 1884; and in the Report which was issued by Mr. Thomas J. Moore, the Curator, later in the same year. The Museum distributes a series of boxes of specimens, and these are removed from school to school at stated intervals.

In many districts, however, and especially where the public Museum is more or less remote, the system so generously inaugurated by the Liverpool Museum will not be found available. In some of our large provincial towns, indeed, where there is a Museum, such a scheme could not be carried out without a great extension of the work of the Museum, for which there is at present no provision. Where this is so, and alas, it is quite general, an attempt is made in many of our schools to gather together what must necessarily be a desultory and very limited collection. I am afraid that few schools, indeed, can show such a typical series of natural history specimens as that sketched by Prof. Flower in NATURE (vol. xli. p. 177).

Here, then, is a good work for the secondary schools which are now and again springing up all over the country. In each of these academies and high schools there is a science department, which, besides its chemical apparatus and the like, can boast, no doubt, of a number of objects gathered at random. And though these may be far more numerous than the specimens to be seen in the ordinary school in the next street, still, how far is the collection from being systematic and typical! The specimens are usually kept, moreover, in drawers, and at any rate with little attempt to display, arrange, or name them. But were the facilities for gathering specimens increased; were a room set apart and furnished with cases for their reception; were, in fact, the secondary school encouraged to get together a double series of objects—one for circulation in the surrounding district, and one for its own use—the benefits now being enjoyed in Liverpool might be extended to other towns without waiting for the public Museum to take the matter up. For each town, in this way, one or two reasonably typical collections, including actual specimens, models, and diagrams, would be provided; and the amount expended at present in individual endeavours would go far towards having this done with considerable completeness.

A good outline of what should be aimed at in such a museum is given in the article by Prof. W. H. Flower, cited above. He has also contributed a series of papers on "Methods," which will be found of the utmost service (NATURE, vol. xv. pp. 144, 184, 204); and it will be seen from these latter that it is quite possible to prepare a great portion of the museum in the school. Still, no better model could be copied than that provided at Liverpool, both as regards the choice of the specimens, and the method of circulating them. The pamphlets referred to above contain information on both points. I should only take the opportunity of recommending that which I have incidentally mentioned in the opening sentences, viz. the addition of important articles of commerce and manufacture.

With such a museum at the disposal of our schools, and provision made for its growth, and the display of a duplicate series of specimens in the secondary school itself, the results of our teaching would be far more real and lasting, and we might now and then touch a sympathetic chord, and awaken an interest having a lifelong influence. ALEXR. MEEK.

University College, Dundee.

[1] Read before the Philosophical Society of Glasgow in 1888.

JAMES CROLL, F.R.S.

BY the death of this well-known writer geological literature loses one of its most voluminous and able contributors. Though not in the proper sense of the word a geologist, he had made himself well acquainted with many geological problems, and first attracted notice more than five-and-twenty years ago by the brilliance and suggestiveness of his attempts to solve them. He was born in 1821 at Little Whitefield, in Perthshire, and after the usual brief schooling of a peasant's son he was apprenticed as a millwright in his native village. The employment allowed him leisure for reading, and he devoted himself with ardour to the study of philosophy and of physical science. At the age of twenty-four, however, the effects of an accident which he had met with in boyhood compelled him to seek a less laborious vocation, and eventually he became agent for an insurance company. These early years gave but little promise of the particular bent of his genius by which he would attain distinction. Eventually his general acquirements and the zeal with which he was known to devote his spare time to philosophical reading attracted the interest of the governing body of the Andersonian University and Museum in Glasgow, and in 1859 he was appointed keeper at that establishment. He had already found his way into print by publishing anonymously a

volume on the "Philosophy of Theism." But his new position in an institution devoted largely to the teaching of science led him to throw himself more fully into the study of physics. In 1861 he published, in the *Philosophical Magazine*, his first contribution to scientific literature—a paper on an electrical experiment of Ampère's.

About that time the Geological Society of Glasgow was founded, and became the centre of an active company of geologists who specially took up the study of the traces of the Glacial period, so striking and abundant in the west of Scotland. Croll was drawn into the prevalent enthusiasm, and soon with characteristic ardour and acumen began an investigation of some of the physical difficulties which had arisen in the course of geological inquiry. In 1864 he published his remarkable essay, "On the Physical Cause of the Change of Climate during the Glacial Epoch." This paper speedily attracted the notice of men of science. In it the author endeavoured to find a true cause for the extension of snow and ice during the Ice Age far beyond their present limits. For this purpose he invoked the aid of astronomical and terrestrial physics, and he provided an explanation which captivated geologists by its simplicity as well as by the wide range of phenomena which it helped to elucidate.

It was this paper which laid the foundation of his scientific reputation. It was likewise the means of opening up for him a new and more congenial employment, for it led to his being selected by the present Director-General of the Geological Survey to take charge of the maps and correspondence of the Survey in Edinburgh. He was appointed to this office in 1867, and found himself able to prosecute with more vigour than ever the researches in physical geology which had now so great a charm for him. The question of the origin of climate led him into a far wider field of investigation than he had at first contemplated. It brought him face to face with many theoretical problems which geologists had been unable to solve. These he attacked with characteristic energy. He enforced his arguments with a single eye to the discovery and establishment of truth, and exposed without reserve views which seemed to him erroneous. With no intention of rousing controversy, he soon found himself in collision with other writers who disputed his arguments. One of the most interesting and vigorous of these disputations was with the late Dr. W. B. Carpenter, regarding the theory of Oceanic Circulation. Croll maintained with great force and with general approbation the position for which he contended, that the prime motors in the circulation of the ocean were the winds. After publishing many papers on this and cognate subjects, he collected, condensed, and partly re-wrote these, adding fresh materials to them, and issuing the whole as his well-known work on "Climate and Time in their Geological Relations," which appeared in 1875. Though much division of opinion was aroused as to the real value of some of his views in relation to the establishment of sound geological theory, there was a general recognition of the originality and acuteness of his mode of dealing with accepted facts and principles, and of the value of his writings as stimulating and directing inquiry. He was accordingly elected a Fellow of the Royal Society in 1876, and the University of St. Andrews conferred on him the degree of LL.D.

By degrees, however, Dr. Croll's health began to fail. He suffered so intensely from pains in the head that he was compelled, in 1881, to resign his appointment in the Geological Survey, and retire on the miserably small pension to which, by the rigid rules of the Civil Service, his length of service only entitled him. By exercising the greatest care he was still able at intervals to resume his studies in geological physics, and to publish occasional papers, partly in reply to his critics, who were now increasing in number and pertinacity. In 1885 he published a smaller volume embracing some of these papers, and much new material under the title of "Discussions in Climate and Cosmology."

Dr. Croll's investigations into the geological history of terrestrial climate had led him to consider the question of the origin of the sun's heat, and thence to reflect on the probable condition and development of nebulæ and stars. The later chapters of the volume just mentioned were devoted to these subjects, which he would fain have discussed more at length, had not the increasing failure of his bodily powers warned him that, if he wished still to return to that philosophy which was his first love, he must husband his remaining strength. Nevertheless, the attraction of these astronomical problems proved insuperable. He continued to work at them, gradually enlarging the scope of the investigation until it embraced not the earth and the sun merely, but the origin and development of the whole material universe. At last he followed his usual method, gathered together his various contributions to the subject, trimmed, enlarged, and modified them, and published them in a separate volume, entitled "Stellar Evolution and its Relation to Geological Time."

The publication of that work marks the close of his labours in more definitely scientific inquiry. He was now free, with such remaining strength as he could command, to re-enter the field of philosophical speculation in which he had spent his earliest years of mental exertion, and which for nearly thirty years, through all the engrossing attractions of geological inquiry, had never lost its fascination for him. Accordingly he betook himself once more to the study of such subjects as Force, Matter, Causation, Determinism, Evolution, and proceeded to apply the facts and principles with which he had in the interval been dealing so actively to the problems in philosophy that had aroused his thoughts in the early years of his life. In spite of his increasing infirmity, he persevered in committing to writing the ideas which he had now matured, and this year he sent to press his last work, published only a few weeks ago, "The Philosophical Basis of Evolution."

Of all recent writers who have contributed so much to current scientific literature, probably no one was personally so little known as Dr. Croll. His retiring nature kept him for the most part in the privacy of his own home. But he endeared himself to those who were privileged with his friendship by his gentleness and courtesy, his readiness to help, and the quiet enthusiasm with which he would talk about the topics which absorbed his thoughts. After quitting the Geological Survey of Scotland he tried residence at different places in hopes of finding one where his failing bodily health would least impede the powers of his mind, which he retained with singular freshness up to the close. He settled at last in the town of Perth, where he spent the few remaining years of his life. Struggling on in spite of several ominous warnings, he finished his last book just before the final stroke which carried him off on Monday, the 15th inst.

A. G.

NOTES.

THE President of the Board of Trade has appointed a Committee, to consider whether any, and if so what, steps should be taken for the provision of electrical standards. The following are the members of the Committee:—Lord Rayleigh and Sir William Thomson (representing the Royal Society), Prof. G. Carey Foster and Mr. R. T. Glazebrook (representing the British Association for the Advancement of Science), Dr. John Hopkinson and Prof. W. E. Ayrton (representing the Institution of Electrical Engineers), Mr. E. Graves and Mr. W. H. Preece (representing the General Post Office), Mr. Courtenay Boyle and Major P. Cardew, R.E. (representing the Board of Trade).

The first meeting of the Committee will be held at the Board of Trade on Thursday, January 15. Sir Thomas Blomefield, of the Board of Trade, will act as secretary to the Committee.

THERE ought to be no doubt as to the response to the appeal which has been addressed to Lord Salisbury with respect to Egyptian monuments. As everyone knows, they are among the most interesting monuments in the world, and it is scandalous that they should be exposed to wanton injury. The signatures to the memorial include many eminent names, and we may hope that a suitable inspector will speedily be appointed.

THE Medical Faculty of University College, Dundee, St. Andrews University, in conjunction with the Royal Infirmary of that city, have appointed Prof. Percy Frankland and Dr. Stalker as delegates to visit Berlin in order to study Dr. Koch's new method for the treatment of tuberculosis.

THE committee appointed by the Royal Horticultural Society to consider the best way of doing honour to the memory of the late Mr. Shirley Hibberd met on December 19. They unanimously decided that a portrait of Mr. Hibberd should be secured, and placed in the hands of the trustees of the Lindley Library, on behalf of the Royal Horticultural Society. Any surplus that may remain after the payment of expenses connected with the preparation of the portrait is to be invested for the benefit of Mr. Hibberd's orphan daughter. Dr. Masters is chairman of the committee appointed to carry out the scheme.

THE Lord President of the Council has appointed Dr. C. Le Neve Foster, Inspector of Mines under the Home Office, Professor of Mining in the Royal College of Science, London.

THE Board of Agriculture has approved of the scheme for establishing a Chair of Agriculture at the Yorkshire College, and it has been decided that a Professor shall be appointed at a salary of £300, with emoluments in addition.

IN an interesting pamphlet on agricultural education, Mr. P. McConnell, Lecturer on Agricultural Science at Balliol College, Oxford, refers to the supposed want of teachers competent to teach scientific farming. In his own experience in the matter—and it has not been little—he has found that there is no such want. On the contrary, he says, the great want is the want of students to be taught by such teachers as we have. He contends that agricultural science can be taught at any College where there is already a science curriculum, and that, in fact, "it is only there that we can hope to have the matter developed on a system cheap enough to have it brought within the reach of ordinary farmers."

THE following are the probable arrangements for scientific lectures at the Friday evening meetings at the Royal Institution before Easter 1891:—January 23, Lord Rayleigh, F.R.S., some applications of photography; January 30, Lord Justice Fry, British mosses; February 6, Prof. J. W. Judd, F.R.S., the rejuvenescence of crystals; February 13, Prof. A. Schüster, F.R.S., some results of recent eclipse expeditions; February 20, Edward Emanuel Klein, F.R.S., infectious diseases, their nature, cause, and mode of spread; March 6, Prof. Dr. J. A. Fleming, electro-magnetic repulsion; March 20, Prof. W. E. Ayrton, F.R.S., electric meters, motors, and money matters.

PROF. DEWAR will deliver at the Royal Institution a course of six lectures (adapted to a juvenile auditory) on frost and fire, on the following days, at three o'clock:—Saturday, December 27, Tuesday, December 30, Thursday, January 1, Saturday, January 3, Tuesday, January 6, Thursday, January 8.

MESSRS. NEWTON AND CO. are making for the Royal Institution a new electric lantern, which will be first used in Prof. Dewar's Christmas lectures. The arc light is fixed on an adjusting table, and the body of the lantern revolves so as to bring any one of the fronts opposite the fixed light.

MR. C. CALLAWAY, D.Sc. (Lond.), has been directed by the Shropshire County Council to inquire into the needs of the county with regard to scientific instruction, and to present to the Technical Education Committee of the Council a report on the subject.

IN the *Kew Bulletin* for December there is a letter from Mr. G. T. Carter, C.M.G., on the attempts which have been made to develop the agricultural industries at the Gambia. It affords, as the *Bulletin* observes, striking evidence of the almost insuperable physical difficulties which stand in the way of the permanent success of such efforts. The *Bulletin* notes that by the West African agreement between Great Britain and France of August 10, 1887, a frontier line between the English and French possessions was established. In accordance with its provisions a Special Commission of Delimitation was appointed to trace upon the spot the line of demarcation between the English and French territory. The partition of tropical Africa amongst European nations has made it more than ever a matter of importance to procure materials for, at any rate, a rough survey of its botanical resources. It was desirable to use the opportunity presented by the Gambia Delimitation Commission for the purpose. The Colonial Office was, however, unable to find the funds for attaching a botanist to the staff. But they were willing to allow a medical officer to be selected who would do what was possible in the way of botanical exploration. The appointment was accepted by Mr. J Brown-Lester, M.B., C.M., of the University of Edinburgh. He was supplied with the necessary botanical outfit from Kew, and left Liverpool with the expedition in the s.s. *Congo* on November 15.

IN addition to the section on cultural industries at the Gambia, the *Kew Bulletin* for December contains much valuable information on the production of prunes in the south of France, the cultivation of perfumery plants in the colonies, banana disease in Fiji, and fibre productions in the Caicos.

WE are glad to see that the City Commission of Sewers are devoting serious attention to the smoke nuisance. At a recent meeting the Sanitary Committee brought up a report relating to frequent complaints on the subject in the City. They stated that for years past Bills had been introduced into Parliament giving local authorities greater powers to deal with such cases, but none of these measures had become law. They recommended that in the next suitable instance a prosecution should be directed against the offenders. Dr. Sedgwick Saunders, medical officer of health, said he had seen the experiments on the Embankment which were being conducted by Mr. Elliott, of Newbury, and the results were eminently satisfactory, especially so far as they related to smoke from furnaces and shafts. They were not so satisfactory in regard to domestic fires. The report was carried, and the Sanitary Committee was directed to investigate and consider the best means of abating the smoke nuisance, and to report thereon to the Commission.

ACCORDING to a telegram from San Francisco, there has recently been an eruption of the volcano at Macao.

THE Report of the Meteorological Council for the year ending March 31, 1890, shows that the work included under the three departments—ocean meteorology, weather telegraphy, and meteorology of the British Isles—is actively carried on. Owing to the want of information in the Pacific, which was felt on the occasion of the Samoa cyclone in March 1889, the Council have decided to establish stations on some of the islands there, with the view of obtaining further observations. The information

received by telegraph as to the state of the weather on the British coasts is now conspicuously displayed outside the office twice daily for the use of the public. Among the various reports issued, the Weekly Weather Report merits special mention, as it supplies a very complete and instructive view of the weather changes day by day over the greater part of Europe. Among the various experiments which have been carried out may be mentioned those for determining the pressure of wind on plates of various sizes and inclined at different angles. These experiments have been made with great skill by Mr. W. H. Dines, and the results have been partially published. The determination of solar radiation is a matter upon which considerable uncertainty exists, as no two instruments can be depended upon for giving similar results under similar circumstances. Experiments with two sets of Violle's actinometer apparatus, consisting of *boules conjuguées*, or two hollow copper spheres, one coated with lamp-black and the other gilt, surrounding the bulbs of two thermometers precisely similar in all respects, have been under trial at Kew Observatory, with the view of determining whether their relative values are constant. The result of the experiment is not yet published. The Report tates that there are about 11,000 volumes and pamphlets in the library, containing meteorological data from all parts of the world. The books and other documents are accessible to scientific men for reference at the Meteorological Office; and to facilitate inquiry, reference catalogues are prepared both under authors and subjects.

ONE of the decisions of the last Congress of Russian Naturalists was to the effect that a *Meteorological Review* should be published in Russian, under the direction of the Academy of Sciences. The first volume has been issued, and contains several valuable papers, namely:—On the comparison of the normal barometers of the West European Observatories, by A. Shenrock; on the average temperatures which can be deduced from observations of the maximum and minimum thermometers, by E. Leist; on magnetic observations in Caucasia, by E. Assafrey; and on the Lena, by E. Stelling; on the thunderstorms in Russia in 1886, by E. Berg (9544 observations at 549 different places having been taken into consideration); and on the accumulations of snow on Russian railways, by B. Sreznevski.

THE Board of Editors at the Columbia College, New York, have decided to publish in January the first number of a monthly review, which will be devoted to "the scientific study and discussion of education." It will be known as the *Educational Review*, and will include within its scope education of every grade, higher, secondary, and primary. Each number will contain signed articles on topics of current interest, critical notes and discussions on educational subjects, "an account of important movements in educational thought throughout the world, and results of contemporary psychological research so far as the same have an educational significance."

AN important work on Russian ethnography is being published by A. Pypin. The first volume contains the history of ethnographical research in Russia, and deals with the ethnography of the great Russian stem.

STUDENTS of ethnography will be sorry to hear that Adrian Jacobsen, who has done so much good service by the ethnographical collections he has brought together, finds his scientific labours so unprofitable from a material point of view that he is compelled to abandon them. The attention of Dr. Bastian was attracted to Jacobsen by a most valuable collection he had formed in Greenland, Lapland, Labrador, and elsewhere in 1876-80. The Ethnological Committee founded by Dr. Bastian commissioned Jacobsen to collect objects for the Berlin "Museum für Völkerkunde"; and from 1881 to 1883 he devoted himself to the accomplishment of his task, bringing back to Berlin from the north-western regions of America no fewer than 8000 specimens. In the same service he travelled in 1884 and 1885 among the peoples of Eastern Russia and in many parts of Asia, returning with 3000 objects of great interest; and in the course of a third journey, in 1887 and 1888, he secured 5000 specimens in Singapore, Java, Celebes, and other regions. There are about 90,000 objects in the Berlin Museum, and more than one-sixth of them have been obtained by this skilful and enthusiastic collector, whose devotion to his chosen mission has often placed his life in danger. *Globus*, by which these facts are recorded, finds it hard to believe that "for such a man Germany has no further work and no further gratitude."

La Nature records an interesting archæological discovery which has lately been made near Apt, in Vaucluse, in the valley of the Caulon. M. Rousset, a retired inspector of forests, while superintending the digging of a ditch, was lucky enough to find, on a bed of pebbles, at a depth of 2·50 metres, the remains of what seems to have been a prehistoric workshop. The flint implements had such sharp edges, and were generally in so excellent a state of preservation, that they had evidently never been disturbed from the time when they had been chipped into shape. Among the objects were three nuclei, and students who have been examining them have succeeded in reuniting with each nucleus the fragments broken from it. Thus it is possible to note exactly the procedure of the prehistoric workmen.

M. EDOUARD MARBEAU contributes to the current number of the *Revue Française de l'Étranger et des Colonies* an instructive paper on what he calls "the depopulation of France." From Prof. Léon Le Fort he quotes the following comparison between France and other European countries. For every group of 1000 inhabitants there are born in Hungary 42 children; in Germany, 39; in England, 35; in France, 25. In 1778 the number in France was 38·4. At the present rate of increase, the population would be doubled in Saxony in 45 years; in England in 52 years; in Prussia, in 54 years; in France, in 198 years. If the period of 1886-89 were taken, the time for the doubling of the French population would be 349 years. The slow rate of increase excites much anxiety among thoughtful Frenchmen. It compels them, as M. Marbeau says, to regard "the foreign invasion" as a benefit. At the last census, there were in France 1,137,037 foreigners, three times as many as were to be found in England and Germany combined. These immigrants come chiefly from Belgium, Germany, Italy, and Spain. Recent inquiries show that only 408,000 persons of French birth are living out of France. Of these, 50,000 are in Switzerland; 26,000 in England; 17,000 in Spain; 10,000 in Italy; 55,000 in Belgium; 100,000 in the United States; 60,000 in La Plata.

THE eighteenth fasciculus of M. Fabre's "Traité Encyclopédique de Photographie" (Gauthier-Villars) gives a very useful and interesting account of the methods employed in astronomical photography of every description, and the decisions of the International Star-charting Congress.

DR. G. B. LONGSTAFF's "Studies in Statistics, Social, Political, and Medical," will be issued by Mr. Edward Stanford on January 12.

THE following science lectures will be given at the Royal Victoria Hall during January:—January 6, the moon, by Dr. Fleming; January 13, glaciers, by Prof. A. H. Green; January 20, our bodies, by Dr. P. H. Carpenter; January 27, all about spectacles, by Dr. Collins.

AT a recent meeting of the Asiatic Society of Japan, held at Yokohama, Admiral Belknap, of the United States Navy, read a paper on the depths of the Pacific Ocean. Admiral Belknap

was in Japan in 1874, in command of the U.S.S. *Tuscarora*, engaged in surveying the proposed route for a Pacific submarine cable. The greatest depth found on the voyage was 3287 fathoms, and H.M.S. *Challenger*, then on her exploring voyage, had not discovered anything in the Pacific of as great a depth. But upon leaving Yokohama the *Tuscarora* made very deep soundings. Only 100 miles from the coast 3427 fathoms were found, and a little further on 4643 fathoms went out without bottom being touched. Still keeping on the great circle track a number of soundings of over 4000 fathoms were made, the deepest being 4655. After re-coaling at Hakodate a fresh departure was made, and the Kuriles were skirted, and here again very deep water was found, except in one place, where there is a ridge of land on which there was only 1777 fathoms, whilst there was 3754 on the western side of it, and 4037 on the eastern side, only eighty miles from land. Admiral Belknap observed that there is, therefore, evidently a deep submarine valley running parallel with the coast of Japan, and some 250 miles in width. Whether the Kuro Siwo, or Japan current, corresponding in a sense to the Gulf Stream, has anything to do with this is a matter for surmise. Since the *Tuscarora* first showed us these great depths others have been discovered. The *Challenger* after leaving Japan found 3750 fathoms 200 miles east of Cape King, and nearly the same depth another 200 miles farther, after which the water shoaled. She also got 4475 fathoms only 150 miles from Guam in the Caroline Islands. The U.S.S. *Albatross* found 3820 fathoms off the coast of the Aleutians, and the U.S. Coast Survey steamer *Blake* got 4561 fathoms 70 miles north of Porto Rico, whilst H.M.S. *Egeria*, surveying in the South Pacific, has succeeded in getting depths of 4428, 4295, and 4530 fathoms. Subsequent researches have proved that the deepest portions of both the Atlantic and Pacific Oceans are close to their western shores. The Admiral then gave some description of the apparatus employed, and after paying tribute to the English and American Navies for their researches, he concluded a most interesting lecture by suggesting that the Japanese Naval Service should take up the work, more particularly on their own coasts and along the course of the Kuro Siwo.

THE additions to the Zoological Society's Gardens during the past week include a Wild Cat (*Felis catus* ♂) from Scotland, presented by Mr. Osgood H. Mackenzie; an African Cat (*Viverra civetta* ♀) from West Africa, presented by Mr. John J. Pitcairn, M.R.C.S., F.Z.S.; two Weka Rails (*Ocydromus australis*) from New Zealand, presented by Mr. Edward T. Dixon; a Common Tequexin (*Tupinambis tequexin*) from Rio de Janeiro, presented by Mr. Edward Sloane; a Himalayan Bear (*Ursus tibetanus*) from Tibet, deposited; a Molucca Deer (*Cervus moluccensis* ♀), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

STARS WITH PECULIAR SPECTRA.—A communication from Prof. E. C. Pickering to *Astronomische Nachrichten*, No. 3008, announces the discovery of the following stars having peculiar spectra, and of some new variables in the constellations Triangulum and Hydra :—

Designation of star.	R.A. 1900.	Decl. 1900.	Mag.	Date of photograph.	Description of spectrum.
	h. m.	° ′			
D.M. + 33°·470	2 31·0	+33 51	9·2	1890 Oct. 13	III. Type. Bright hydrogen lines.
Cord. G.C. 7192	5 59·4	− 6 42	5·8	1888 Feb. 15	F line bright.
„ „ 17717	12 56·3	−70 56	6·6	1890 May 14	F line bright.
„ „ 18770	13 43·4	−27 44	7·0	„ May 15	III. Type. Bright hydrogen lines.
„ „ 18947	13 51·6	−55 51	8·0	„ May 25	IV. Type.
„ „ 20554	15 48	−69 42	6·2	„ May 26	IV. Type.

It is remarked that "the stars D.M. + 33°·470 and Cord. G.C. 18770 in the above list have a spectrum in which the lines due to hydrogen are bright, as in that of *o* Ceti and other variables of long period. They were therefore suspected of variability." An examination of the Harvard College Observatory photographic charts and spectra indicates that the former star varies between 7·1 mag. and 9·2 mag., and the latter between 7·0 mag. and 10·4 mag. Three observations of Cord. G.C. 18770 by Stone gave a magnitude 6. It is interesting to note that the Rev. T. E. Espin announced the probable variability of the star D.M. + 33°·470 in *Walsingham Observatory Circular*, No. 27 (NATURE, November 13, p. 45).

A photograph of the spectrum of T Ceti shows that it belongs to the third type. A photograph of the spectrum of the variable of the Algol type, viz. S Antilæ (R.A. 9h. 27·9m., Decl. −28° 12′), discovered by Paul in 1889, shows the hydrogen lines at λ 410 and λ 434 (*h* and G) narrow, while the lines at λ 394 and λ 397 are very broad. This would place it in "an intermediate class between stars of the first and second types."

THE ROTATION OF JUPITER.—A report in the *Revue Générale des Sciences*, of the meeting of the St. Petersburg Academy of Sciences held on November 18, contains an account of a paper by M. Biolopolski, on the rotation of the planet Jupiter. Cassini appears to have been the first to point to the analogy between the rotation of Jupiter and the sun, by demonstrating that the velocity at the equator is greater than on the rest of the surface of these two bodies. It is known that on the sun the angular velocities are functions of the heliographic latitudes. By utilizing observations and drawings made by Cassini, Herschel, Schröter, and many other observers, M. Biolopolski has been able to determine more than a hundred angular velocities at various "Jovigraphic" latitudes. Among these velocities two predominate, one of 9 hours 51 minutes, and another of 9 hours 55·5 minutes (approximately). The first is found almost exclusively in the zone between 0° and 5°, in both hemispheres; the second is obtained from the remainder of the surface, except between 5° and 10°, both N. and S., where the two velocities appear to occur with equal frequency. These conclusions are confirmed by Mr. Keeler's drawings of Jupiter, made at the Lick Observatory during this year.

EDDIE'S COMET (?).—A telegram from Cape Town Observatory to the editor of the *Astronomische Nachrichten*, with regard to the supposed remarkable comet seen by Mr. Eddie on October 27 at Grahamstown, reads: "It has been cloudy here, October 27; has not been seen by anyone else."

NAMES FOR ASTEROIDS.—The following names have been given to recently-discovered asteroids :—

(283) Emma.	(289) Nenetta.
(284) Amelia.	(293) Brasilia.
(285) Regina.	(294) Felicia.

PERIOD OF χ CYGNI.—Mr. Chandler represents the inequalities in the period of the variable χ Cygni by the formula

$$406{\cdot}02 \text{ E days} + 0{\cdot}0075 \text{ E}^2 \text{ days} + 25^\circ{\cdot}0 \sin (5^\circ \text{ E} + 272^\circ),$$

where E is the normal epoch of a maximum. This formula, containing quadratic and periodic terms, gives the epochs of maxima much nearer than those derived from Schönfeld's uniform period of 406·5 days.

BIOLOGICAL NOTES.

ILLUSION OF WOODPECKERS AND BEARS.—Mr. J. D. Pasteur, Inspector of the Post and Telegraphic Service at Java, communicated to Dr. F. A. Jentink, in July last, the following very curious and interesting facts about woodpeckers, who, under the illusion that the buzzing sound so apparent on applying the ear to telegraph poles is caused by the vigorous efforts of gnawing or boring insects, make large holes in the timber, on a hopeless chase after such. He incloses a piece of a telegraph pole made of teakwood, with two woodpeckers (*Picus analis*), from the Kediri Residency, Java. The wood, which is of iron hardness, is perforated with rather large holes near the place where the insulators had been attached. Although Inspector Pasteur passes thousands of telegraph poles under view each year, only in a very few

cases has he found any damage done to them by woodpeckers, and, until now, the damage done has always been on the living kapok trees (*Eriodendron anfractuosum*), which are used in Java for this purpose. The piece of telegraph pole now sent is the only instance known to him of damage being done to the sound and very hard poles of the teak (*Tectona grandis*). Besides the above-mentioned woodpecker, from time to time the rare little *Picus moluccensis* was seen also among the others at work. Mr. Pasteur remarks on the great rarity of such a phenomenon: in the Paris Electrical Exhibition of 1881 there was exhibited, as a great curiosity, a telegraph pole sent from Norway, which was perforated by a hole of 7 centimetres in diameter. The Norwegian Administration was for a long time uncertain to what cause to ascribe this damage done to poles, which were otherwise quite sound, till a mere chance at last revealed woodpeckers at work. In Norway, too, another equally remarkable case of damage had been noted as done to telegraph poles by the large stones, which are heaped round their base to insure their stability in the ground, being removed and scattered, apparently without any reason. This, which was for a length of time inexplicable, was at last found to be the work of bears, who apparently mistook the sound in the timber for the buzzing of a swarm of bees. It is too much to expect of either bears or woodpeckers that they should be versed in the ways of modern science. (*Notes from the Leyden Museum*, October 1890, p. 209.)

ALGÆ LIVING IN THE SHELLS OF MOLLUSKS.—For a long time back zoologists have, in a more or less desultory and unsatisfactory manner, made known to us the occurrence, in the hard parts of both living and extinct animals, of sundry ramifying canals, which have been described as the work of vegetable parasitic forms. These forms have been found in shells, corals, sponges, in fish-scales, and, indeed, the literature of the subject is quite a large one. Until the other day, however, there was but little progress made in our knowledge of the life-history of these parasitic plants, but the researches of Reinsch (*Bot. Zeit.*, 1879), and especially of Lagerheim (*Oefver. af K. Vet. Akad. Forhand.*, 1885), marked a new era in their investigation. A memoir, recently published in the Report of the Botanical Congress held in Paris last year, from the pens of MM. Ed. Bornet and Ch. Flahault, reduces the whole subject to order, describes the method of investigation, and a number of new genera and species. As most of these minute plants grow within the calcareous shells of Mollusca, it is not possible to study their morphology, unless by decalcifying these structures; this is effected by placing them in a sufficient quantity of Perenyi's fluid, consisting of four volumes of a 10 per cent. solution of nitric acid, three of alcohol, and three of a 5 per cent. solution of chromic acid, which fluid, while it dissolves the carbonate of lime, fixes the protoplasm, and leaves it and the other cell-contents (after a good washing) in a fit state for the use of reagents or staining. The same general features seem to attend the gradual perforating of the shell-structure by these parasites. At first they penetrate just under the outer epidermis of the shell, then speedily they make further advances, until in time the greater quantity of the hard structures disappear. This will account for the gradual extinction of dead shells in tranquil bays, where they are not subject to being ground into powder by the force of the waves. In addition to marine shells, instances of the occurrence of these forms in fresh-water shells are given, and they would also seem occasionally to lead an independent existence on calcareous rocks. Of the Chlorosporeæ, the most important is *Gomontia polyrhiza*, briefly described by Bornet and Flahault in Morot's *Journal of Botany* for May 1888, but here fully described and illustrated. This plant has a minute thallus, consisting of ramifying filaments, certain cells of which become altered into sporanges, and become detached; from these issue biciliated zoospores and immobile spores (the aplanospores of Wille). The germination of these spores seems to differ; the aplanospores increase in volume, emit one or more rhizoids, and soon present an appearance resembling that of a sporangium, but smaller. Whether the zoospores conjugate or not has not yet been observed—the difficulties in the way of observation are great—but they soon give origin to filamentous growth of a bright green colour. The other species described are *Siphonocladus voluticola*, *Zygomitus reticulatus*, and *Ostreobium queketti*. Among the Phycochromaceæ are enumerated *Mastigocoleus testarum* (Lagerheim), *Plectonema terebrans*, *Phormidium incrustatum*, and *Hyella cæspitosa*—this last a very interesting species; its thallus has a great resemblance to that of the Sirosiphoniaceæ, but in reality it belongs to the Chamæsiphoniaceæ, and it has two modes of propagation—one by the ordinary dissociation of vegetative cells, and the other by the formation of spore-like bodies resulting from the division of the contents of certain cells into a great number of minute cellular spheroids, after the manner in Dermocarpa, these cells being either terminal or intercalary. Two fungoid forms are described and figured: *Ostracoblabe imp*[illegible], for the form regarded as *Achlya ferax* by Duncan, and *Lithopyt*[illegible] *gangliforme*. This memoir seems to open a new field for research. Without doubt many new facts, as well as new spec[illegible] await the patient labours of our botanists among these shell-frequenting species, and the way is made plain for them in this memoir. (*Bull. Soc. Bot. de France*, tome xxxvi., 1890.)

THE AUSTRALIAN ABORIGINES.

IN the latest number of the Journal and Proceedings of the Royal Society of New South Wales (vol. xxiii. part 2) there are two remarkably interesting articles on the Australian aborigines. One of them is by the Rev. John Mathew, Coburg, Victoria; the other by Mr. Edward Stephens, Bangor, Tasmania. It may be worth while to give [illegible] general idea of the contents of both papers.

Of the two, that by Mr. Mathew is by far the more elaborate. It represents the results of observation and study which have evidently been carried on for many years. A considerable part of it is devoted to the question, Who are the Australian aborigines? and about this he has much to say that must command the attention of ethnologists. He holds that the continent was first occupied by a homogeneous people, a branch of the Papuan family, and closely related to the Negroes. These settlers came from the north, but whether from New Guinea or any other island of the Eastern Archipelago we have no means of knowing, because at the time of their arrival the islands to the north were probably all inhabited by people of the same blood. Mr. Mathew thinks that these first-comers, the veritable Australian aborigines, occupied all the continent; and, having spread right across to the southern shores, crossed what is now Bass's Strait, which may at that distant date have been dry land, their migration terminating in Tasmania. According to this view, the now extinct Tasmanians were a survival of the primitive Australian race; and Mr. Mathew is at great pains to mass the evidence in favour of this theory.

One of the strongest arguments against the hypothesis is that the Tasmanians differed in appearance from their neighbours across the Strait. By a careful comparison of various accounts of both races, one of which is well known to him, he has convinced himself that the physiological differences narrow down to these: that, as compared with the natives of the continent, the islanders were on the average of shorter stature, of much darker complexion, and had hair of very different quality. These differences, he thinks, are to be explained by the fact that the Australian aborigines were greatly modified by fresh settlers, whereas the Tasmanians, being separated from other races, retained their primitive characteristics. There are now various physical types in Australia, but the Papuan type has not been effaced. Mr. Mathew cites various authorities to show that there is a decided Papuan fringe on the south-eastern and western coasts, with a departure from it landwards and in the north. The hooked nose is a feature common to Papuans, Australians, and Tasmanians.

Having discussed the argument from mythology and tradition, Mr. Mathew goes on to consider the argument from implements. The Tasmanians, as warriors, were much less skilfully equipped than most Australian tribes. They possessed, for example, neither the shield nor the boomerang, nor were their weapons ornamented. But in Australia there is a people at an equally low stage; and, with regard to those who are more advanced, Mr. Mathew suggests that the arts they possess may have reached Australia after the departure of the tribes who peopled Tasmania. His conclusion, after a survey of all accessible facts, is that the arms of the Tasmanians were of the same kind as those of the lowest of the Australians; and it is, he maintains, anything but illogical to infer that the "autochthonous" Australians once used exactly the same weapons and implements as those of the islanders. By circumstances which affected only the continent, the arms and implements there were almost universally improved. The author further strengthens

his case by linguistic evidence, and by reference to customs which were common to Tasmania and the whole or part of Australia.

Having thus set forth his ideas as to the earliest inhabitants of Australia, he proceeds to disentangle and identify the other elements which go to constitute the Australian race as it is now. Upon the original Papuan stock of Australia there must have been grafted a very strong scion from another and in some respects very different stem, and the union must have been effected in the remote past, the stock from which the graft came having since then altered by progressive development almost beyond identification. The new element Mr. Mathew believes to have been the Dravidian. "Although," he says, "the Australians are still in a state of savagery, and the Dravidians of India have been for many ages a people civilized in a great measure and possessed of a literature, the two peoples are affiliated by deeply-marked characteristics in their social system and by sure affinities in language." A reference to the boomerang, which is found in India as well as in Australia, is one of the means by which he endeavours to establish this connection. "We search the Malay and Papuan armouries in vain for any trace of it, and are therefore obliged to credit some other race with its introduction to Australia, unless we unnecessarily assume that it was invented here independently. The boomerang is used in Africa about the upper course of the Nile, but we need not travel so far for it across barriers that might be termed impassable, when it is obtainable so much nearer, and in a place from which a highway has led thither almost to Australia's shores. If the framework of society, and those terms which are almost as close to a man as his own name, have both been introduced from India or its neighbourhood, it requires no stretch of imagination to suppose that the boomerang came along with them."

Universal and strong as the Dravidian influence is, it is not sufficient, Mr. Mathew thinks, to account for the great divergence of the Australians from the pure Papuans in physical features and language. He maintains, however, that the phenomena can be explained by the introduction of a Malay element. Mr. Curr is of opinion that the visits of the Malays are only of recent date, and quotes the statement of a Malay, who, in 1803, professed to have been one of the first of his countrymen to visit Australia. According to Mr. Mathew, the evidence of this Malay, whose historical knowledge must have been very limited, is overborne by the physique of the people, in the north especially, but elsewhere as well; by the naturalization of a number of important Malay words, such as the term for "teeth," a change which mere visitors could not effect; and, further, by faces of the Malay type and pure Malay words appearing in localities far removed from casual intercourse, as, for instance, in the extreme east and west. The admixture of Malay blood is supposed to account for the difficulty "that a race such as the Australian, with a Papuan basis, should have the hair straight or wavy, and not woolly. One even cross of a woolly-haired with a straight-haired race would hardly have transmitted such straightness of hair to posterity; but if after a first cross, the fresh invasions, though only in scant filtrations, were of straight-haired people, the effect of the mingling of two straight-haired races with one the hair of which was woolly, would surely be to make the spirals uncurl."

In so far as the succession and distribution or commingling of different races are concerned, Mr. Mathew suggests that the peopling of Australia may be compared with that of Great Britain. Taking the word "Celtic" in the widest sense, he says:—"The Celtic element in Britain is represented by the Papuan in Australia, the Saxon by the Dravidian, the Norman by the Malay. In both cases, population has poured in mainly on one side, the earliest settlers gradually retiring to the further shore. The second race takes entire possession of the centre, shedding the indigenes to either side. Wales and Cornwall might correspond to Victoria, the Isle of Man to Tasmania, not in relative position to the mainland, but in isolation and racial purity, and the Highlands of Scotland would represent Western Australia. In each case, from the first two races the bulk of the people is sprung, and the vocabulary and grammar are inherited; while the third race, sprinkled here and there over the land, has left the slightest lingual traces of its presence."

Dealing with the physical appearance of the natives, Mr. Mathew shows that it is subject to considerable variation, not only in different localities, but even in the same community, and this as regards stature, muscular development, cast of feature, and other particulars. In his opinion the Australians exhibit powers of mind "anything but despicable." In schools it has often been observed that aboriginal children learn quite as easily and rapidly as children of European parents. For three consecutive years the aboriginal school at Ramahyuck, in Victoria, stood the highest of all the State schools of the colony in examination results, obtaining 100 per cent. of marks. But the limit of the native's range of mental development is soon reached; and he has "an inherent aversion to application." He has a strong propensity to mimicry, and "it is astonishing how easily and completely young blacks, not cut off from intercourse with their relatives, but living and working constantly among the whites, fall into European modes of thought." They are not wantonly untruthful, or deficient in courage, or excessively selfish, and they are "by no means lacking in natural affection." But they have no stability, so that their moral qualities are prone to operate capriciously. An almost universal feature of the aboriginal character is "gaiety of heart"; and Mr. Mathew believes this to be a Papuan inheritance. The black is a very vain man, and it is "perhaps as much owing to his vanity or his fondness for praise as to any other motive that he has been got to work at all."

The paper includes instructive paragraphs on dwellings, clothing, implements, food; government, laws, institutions; marriage, man-making, mutilations, burial customs; art, corroborees, sorceries, superstitions; and the Australian languages. Speaking of the magicians called "doctors," corresponding to the medicine-men and rain-makers of other barbarous peoples, Mr. Mathew says:—"The power of the doctor is only circumscribed by the range of his fancy. He communes with spirits, takes aërial flights at pleasure, kills or cures, is invulnerable and invisible at will, and controls the elements. I remember a little black boy, when angry, threatening me with getting his father to set the thunder and lightning agoing. The same boy told me seriously that on the occasion of a raid being made upon the blacks' camp by the native police, one of his fathers—a doctor—lifted him and pitched him a mile or two into the scrub, and vanishing underground himself, reappeared at the spot where the boy alighted." The Australians have "an apprehension of ghosts rather than a belief in them." In the tribe with which Mr. Mathew is best acquainted, they had a term for ghosts, and thought that departed spirits were sometimes to be seen among the foliage; but "individual men would tell you upon inquiry that they believed that death was the last of them." A ghost was called a "shadow," and the conception of its existence was "shadowy" like itself. "The Kabi tribe deified the rainbow—a superstition apparently confined to this people. He lived in unfathomable water-holes in the mountains, and when visible was in the act of passing from one haunt to another. He was accredited with exchanging children, after the fashion of the European fays."

Of Mr. Stephens's paper we have not space to say much. It is of special interest, because it is nearly half a century since he landed, a lad with his parents, in the infant colony of South Australia; and since that time he has had many opportunities of observing the natives. He does not at all agree with those who think that the Australians are "a naturally degraded race." Those who talk in this way, he says, either do not speak from experience, or judge the aborigines by what "they have become when the abuse of intoxicants and contact with the most wicked of the white race have begun their deadly work." "As a rule, to which there are no exceptions, if a tribe of blacks is found away from the white settlement, the more vicious of the white men are most anxious to make the acquaintance of the natives, and that, too, solely for purposes of immorality. The native women have hearts to break, and the native men outraged honour to vindicate, and these have ever been the chief factors in the so-called atrocities of the aborigines of Australia. I saw the natives, and was much with them, before these dreadful immoralities were well known. I saw them, and was often with them, when the old died off, and the race no longer propagated itself; and I say fearlessly that nearly all their evils they owed to the white man's immorality and to the white man's drink."

Mr. Stephens has a very favourable opinion of the capacity of the Australians for mental improvement. A full-blooded native, called Cottrel, whom he knew, was "an agreeable companion, interesting in conversation, full of anecdote and adventure." He married a white woman, and settled comfortably, near the

Bremer, on land given to him by the South Australian Government. "To see him track, or smell the tracks of his own bullocks that had gone astray with a number of others, was a sight long to be remembered"; and he never failed to find them.

An odd and significant incident which occurred long ago is described by Mr. Stephens. Some men of the eastern tribes called at his father's house on their way inland. "There being only my mother and myself at home, and the nearest neighbour some distance away, the men became very bold and bodily entered the house. We had a nice lively little magpie at the time, which we had tamed and taught to say a few words, and to whistle 'There's nae luck about the house,' &c. The magpie hid himself under the sofa, and, singularly incredible as it may appear, it, in a rich, full, clear tone, whistled the tune "There's nae luck,' &c. The natives were strangely silent in a moment. In less time than it takes to pen the words, little mag was out from his hiding-place, biting the naked toes of the savages here, there, and everywhere, and talking at a tremendous rate. They all looked like a lot of scared demons, and madly rushed for the door, as if the old general himself were after them. The door was instantly closed and bolted. The blackfellows never returned, and never knew but that the words came from an avenging spirit, and that they had had a very narrow escape."

GARDEN SCHOLARSHIPS.

IN accordance with the intention of its honoured founder, the Trustees of the Missouri Botanical Garden propose to provide adequate theoretical and practical instruction for young men desirous of becoming gardeners. It is not intended at present that many persons shall be trained at the same time, nor that the instruction so planned shall duplicate the excellent courses in agriculture now offered by the numerous State Colleges of the country, but that it shall be quite distinct and limited to what is thought to be necessary for training practical gardeners.

To this end, the following resolution was adopted by the trustees, at a meeting held on November 19, 1889:—

"*Resolved*, That there be established the number of six scholarships for garden pupils of the Missouri Botanical Garden, to be available on and after April 1, 1890, such scholarships to be awarded by the Director of the Garden on the results of competitive examination, except as hereinafter provided, to young men between the ages of 14 and 20 years, of good character, and possessing at least a good elementary English education; each scholarship to grant such privileges and be subject to such conditions as are provided below or may subsequently be provided by the Trustees of the Garden.

"Until otherwise ordered, two such scholarships shall be reserved for candidates to be named by the State Horticultural Society of Missouri, and the Florists' Club of St. Louis, respectively; provided, that such candidates shall be given scholarships only after passing satisfactory preliminary examinations, and shall be subject after appointment to all tests and regulations prescribed for other candidates and pupils, and that if the names of such candidates are not presented by the societies designated, within sixty days after such action is requested by the Director, the vacancies may be filled by him on competitive examination, as in other cases.

"Each scholarship so conferred may be held by the original recipient for a period not exceeding six years, subject to the following conditions:—

"Each garden pupil shall be required to lead a strictly upright and moral life, and shall be courteous and willing in the performance of all duties prescribed for him. He shall devote his entire time and energy to the labour and studies prescribed for him, except that from time to time he may be granted leave of absence to visit his home or for other good reason, at the discretion of the Director, provided that the aggregate of such absences in any calendar year shall not exceed thirty days. He shall also show such ability in his work and studies as to satisfy the Director that it is advantageous for the scholarship to be held by him; and from time to time he may be subject to both theoretical and practical examinations, or may be given special tasks calculated to test his knowledge or resources. Failure to meet the requirements in any one of these respects, making due allowance for extenuating circumstances, shall forfeit all claim on any scholarship, which may then be awarded to another person in the prescribed manner.

"Garden pupils, appointed as above indicated, shall be regarded as apprentices in the Botanical Garden, and as such shall be required to work in it under the direction of the head gardener, performing the duties of garden hands. They shall be successively advanced from simpler to more responsible tasks; and in such order as may seem best shall be transferred from one department of the Garden to another, until they shall have become thoroughly familiar with the work of all.

"To the end that Garden pupils shall be repaid for their services to the Garden, and that the absence of pecuniary means need not deter any young man from obtaining such training as is contemplated, each regularly appointed garden pupil holding a scholarship shall be entitled to the following wages, payable in equal instalments at the end of each fortnight: for the first year 200 dollars; for the second year, 250 dollars; and for each year after the second, 300 dollars; together with plain but comfortable lodgings convenient to the Garden.

"In order that they may have opportunity to become instructed in the theoretical part of their profession, and in subjects connected therewith, such pupils shall not be required to do manual work in the Garden for more than five hours per day after the first year, devoting the remainder of their time to the study of horticulture, forestry, botany, and entomology, under the direction of the Director of the Garden; and they shall for this purpose be granted free tuition in the School of Botany of Washington University. They shall also receive practical instruction in surveying and book-keeping, so far as a knowledge of these subjects is held to be necessary for a practical gardener charged with the management of an estate of moderate proportions.

"At the expiration of six years, the holder of a scholarship, who is recommended as practically proficient, shall be entitled to examination by the Garden Committee, in the subjects prescribed for study, and on passing such examination to the satisfaction of the Committee and Director, he shall receive a certificate of proficiency in the theory and practice of gardening signed by the Chairman of the Garden Committee and the Director of the Garden. In exceptional cases, candidates may be admitted to examination at the end of the fifth year, when this shall be deemed advisable by the Garden Committee, and on passing such examination satisfactorily, shall be entitled to a statement to that effect from the Director, and to the regular certificate on the subsequent completion of a year's work to the satisfaction of their employers."

All applicants for scholarships, whether named by the societies indicated above or not, will be examined in the following subjects so far as they are taught in the upper classes of grammar schools: English grammar, reading, writing, and spelling; arithmetic; and geography. If the number of candidates for scholarships exceeds the number of scholarships to be awarded at any time, all candidates except those named by the societies indicated will be required to pass a further competitive examination, which will cover history of the United States, English literature, algebra, German, the elements of botany, zoology, and physiology, and such other subjects as may from time to time be prescribed. It is not intended to make the passing of examinations in these last-named branches a requirement for the award of scholarships, but merely in this way to obtain a means of selecting the most deserving and able candidates when it is necessary to reject some. Hence, the Director will always use his discretion as to the importance to be attached to greater or less proficiency in any of the subjects covered by competitive examinations, as well as to the other qualifications of candidates admitted to such examinations.

Under the above provisions, the following announcement is made:—

Two scholarships will be awarded by the Director of the Garden, prior to April 1 next. In case both are not then awarded, the remainder will not be awarded until the corresponding period of the following year, and vacancies which may subsequently arise will be filled annually, after published announcement.

Applications for scholarships, to receive consideration, must be in the hands of the Director not later than March 1. The preliminary examination for all candidates will be held on Tuesday, March 3, at the Shaw School of Botany, 1724 Washington Avenue, St. Louis, between 10 a.m. and 5 p.m. If the number of applicants exceeds two, competitive examinations, based on the subjects indicated above, will be held at the same place on Friday and Saturday, March 6 and 7.

Candidates who live at places remote from St. Louis, and who wish to be spared the expense of coming to the city for examination, may send, with their application, the name and address of the principal of the nearest high school, or of some approved private school, in case he is willing to take charge of such examination for them; but all applications of this character must be in the hands of the Director not later than the middle of February. If the examiner is approved, papers will be sent to him before the date set for the examination, and on the payment of a fee of 2 dollars to him, the candidate may write on them in his presence. If competitive examinations are also required, the same examiner will receive the papers for them in time to submit them to the candidate on the date set for similar examinations in St. Louis, on receipt of an additional fee of 3 dollars as a partial payment for his time in conducting the examination. The papers written on such examinations will be forwarded by the examiner to the Director, who will read them in connection with those written in St. Louis, before making any awards.

Successful candidates will be started in their duties as garden pupils on Tuesday, March 31, at the Botanical Garden. They will be lodged in comfortable rooms in a spacious dwelling adjoining the Garden under the charge of the head gardener, or some other competent person. It is not the intention of the Trustees to furnish table board, but good board can be obtained in the lodging-house or elsewhere at the usual cost. The lodging-house includes a reading-room supplied with the more valuable horticultural and agricultural papers, and also with a small but standard collection of books on the same subjects, which the pupils have free use of. So far as possible, the surroundings of pupils are made home-like, and, without assuming any responsibility for their behaviour, an effort is made to subject them to influences calculated to insure for them gentlemanly manners and habits of industry and investigation.

During the first year of their scholarship, garden pupils will work at the practical duties of the Garden nine or ten hours daily, according to the season, the same as regular *employés* of the Garden, and will also be expected to read the notes and articles referring to the subject of their work in one or more good journals.

In the second year, in addition to five hours' daily work of the same sort, they will be given instruction and will be required to do thorough reading in vegetable gardening, flower gardening, small-fruit culture, and orchard culture, besides keeping the run of the current papers.

In the third year, in addition to five hours of daily labour, they will be instructed and given reading in forestry, elementary botany, landscape gardening, and the rudiments of surveying and draining, and will be required to take charge of clipping or indexing some department of the current gardening papers for the benefit of all.

In the fourth year, besides the customary work, they will study the botany of weeds, garden vegetables, and fruits, in addition to assisting in the necessary indexing or clipping of papers, &c., and will be taught simple book-keeping, and the legal forms for leases, deeds, &c.

The course for the fifth year, in addition to the customary work, will include the study of vegetable physiology, economic entomology, and fungi, especially those which cause diseases of cultivated plants; and each pupil will be expected to keep a simple set of accounts pertaining to some department of the Garden.

In the sixth year, in addition to the manual work, pupils will study the botany of garden and green-house plants, of ferns, and of trees in their winter condition, besides the theoretical part of special gardening, connected with some branch of the work that they are charged with in the Garden.

From time to time changes in this course will be made, as hey shall appear to be desirable, and the effort will be made to give the best theoretical instruction possible in the various subjects prescribed; but it is not intended to make botanists or other scientific specialists of garden pupils, but, on the contrary, practical gardeners.

Applications for scholarships, and any inquiries regarding them, are to be addressed as below, on or before the dates mentioned above. If requested, blanks will be mailed to persons who contemplate making application.

WILLIAM TRELEASE,
Director of the Missouri Botanical Garden.
St. Louis, Mo.

WASHINGTON OBSERVATIONS, APPENDIX I.

THIS volume consists of reports, to the Superintendent, of the Transactions of the International Astrophotographic Congress, and of "A Visit to certain European Observatories and other Institutions," by Albert G. Winterhalter.

In the first report will be found a good detailed account of the most important points that have been discussed in order to obtain the best and most accurate methods by which a chart of the heavens may be made. Among the resolutions that were passed at this Congress, the following may be mentioned:—Refractors shall be used exclusively, the object-glasses of which shall have apertures of 33 centimetres and focal lengths of about 3·43 metres. The aplanatism and achromatism of these glasses shall be calculated for the wave-lengths near the Fraunhofer line G, by which means use may be made of the maximum of sensitiveness of the photographic plates. All the plates will be prepared from a single formula, and as regards their sensitiveness a permanent control will be instituted. In order to eliminate defects in the plates, two series of photographs of the whole sky will be made, and so arranged that stars on the edges of one will be more or less central on the other. In addition to the above-mentioned series of plates, another will be taken with shorter exposures, so as to obtain greater precision in the micrometric measurement of the fundamental stars, and to make possible the formation of a catalogue. The author, in his general conclusions at the end of this report, points out the necessity for a mutual dependence and relation of all workers in astronomy, and he adds, "The necessity becomes urgent in the light of the late development and the multiplying branches of that science. Had there been no practical results of the international reunion at Paris, there would still have remained much good derived from personal acquaintance and discussion."

The second part of the work forms a most valuable record of the instruments that are employed in most of the chief Observatories of to-day. The author made the visits in obedience to orders of the Department and of the Superintendent that were issued to him, all of which he has appended in the latter end of Part IV. To give an account of the various Observatories described in this volume, or even to summarize the information recorded, would occupy too much space, so that we will restrict ourselves to the visit paid to England, and make some brief extracts relating to the Observatories mentioned.

Of course, the first Observatory visited was that of Greenwich, and the author does not give such a detailed account of it as he does of many others, as "no observatory is more intimately known to Americans. This is largely due to the thoroughness with which the parts have been described from time to time, and to the frequency with which the establishment has been referred to as a model in one or the other particular." At any rate, he gives a good description of most of the chief instruments employed, with details of their construction; he also paid great attention to the various styles of domes employed, and the means adopted for rotating them. The photoheliograph is described, also the magnetical and meteorological instruments, and a brief account is given of the chronometer, time signals, clocks, and chronographs.

The next Observatories visited were those of Kew, Huggins's, and Common's; during the author's stay at the last-named Observatory the 5-foot mirror was in progress of rough polish. He also briefly states the means that were going to be adopted for floating the axis, the tube of which would measure 8 feet in diameter, so that its ends would then only have to be confined to the extremities of the tank by pins.

The visits of the author not being strictly confined to Observatories, he went over the workshops of Troughton and Simms, that are situated at Charlton, in which he saw instruments of all kinds in course of construction. As a typical example of the work turned out he takes the transit-circle with an object-glass of 8 inches and a focal length of 9 feet, an illustration of which is given.

The last English Observatories visited were those of Oxford and Cambridge, and after some short historical notes, the various instruments in each are described in detail.

Part III. consists of reports on sundry astronomical and nautical constructions and processes, and amongst the subjects treated may be mentioned the following: the construction of the great dome at Nice, M. Bigourdan's apparatus for determining the personal equation in double-star measurements, various forms of artificial horizons, a new level-trier, public time-service, and the equatorial coudé.

In Part IV. the author relates a few very general conclusions that he has arrived at after his series of visits, some of which we will state quite briefly. Each prominent instrument should have its own building; dwellings for observers should be on the premises; good workshops should be provided, so that repairs may be done on the spot; and electricity should be used throughout. Copies of the orders from the Navy Department follow next in order; and the volume terminates with a list of books, photographs, &c., that were bought at the various places visited.

The work as a whole supplies the reader with an excellent and trustworthy description of many of the chief Observatories of the present day; it may be stated, however, that the author has deemed it necessary to omit a large amount of information on methods, instruments, &c., his reason for so doing being that it will be found in other publications.

The illustrations throughout add greatly to the value of the book, and the American Government ought to be congratulated on the result of the work.

FIELD EXPERIMENTS AT ROTHAMSTED.[1]

THESE memoranda are issued yearly, in order to bring the results of the field experiments up to the present time. The matter is closely condensed, most of the information being in the form of schedules and tables. The results include observations and experiments upon rainfall, drainage, composition of drainage water, disposal of rainfall through percolation and evaporation, as well as upon the effects of artificial manures on various crops, most of which have been grown upon the same land, under strictly regulated conditions, for forty years. To those who are accustomed to follow the results obtained at Rothamsted, there is nothing novel in those portions of the memoranda, as they merely contain the account of a work with which the agricultural public is familiar. No one not already aware of the elaborate nature of the Rothamsted experiments can take up these memoranda without being struck with the vast amount of labour, patience, expenditure, and ability disclosed. Agriculturists will probably be disposed to confine their attention to the effects of fertilizers upon certain crops, but after perusing this interesting document we come to the conclusion that the Rothamsted observations reach much further in their significance than the limits of agricultural practice. They must assist in the solution of physiological questions involving both animals and vegetables, and physical questions relating to the gradual changes wrought upon the surface of the earth through rainfall and atmospheric action. The Rothamsted results, carefully tabulated year by year, contain a mass of data from which important conclusions may be drawn. Among these data we note—(1) Observations upon the determination of nitrogen as ammonia, as nitric acid, and as organic nitrogen, and also some other constituents, in many samples both of the rain and of the various drainage waters collected at Rothamsted. It is only by such observations that any idea can be formed as to the sources of the nitrogen of growing plants. We have here a means for estimating both the amount of nitrogen brought down in rain and wasted through drainage—two factors which must be kept in view when the relations of plants to combined nitrogen at present existing in the soil are to be investigated. (2) Observations on the difference in the character and amount of the constituents assimilated by plants of different botanical relationships, under equal external conditions, or by the same description of plants under varying conditions. (3) Observations on the character and range of the roots of different plants, and on their relative development of stem, leaf, &c. (4) Observations on the composition of the entire plant, and various parts of the same plants, at different stages of growth.

One of the most important subjects, which has acquired fresh interest at the present time, is that of the assimilation of free nitrogen by growing plants. In treating of this deeply interesting question Sir John Lawes says:—"In recent years this question has assumed quite a new aspect. It now is, whether the free nitrogen of the atmosphere is brought into combination under the influence of micro-organisms or other low forms, either within the soil or in symbiosis with a higher plant, thus serving indirectly as a source of nitrogen to plants of a higher order. Considering that the results of Hellriegel and Wilfarth on this point were, if confirmed, of great significance and importance, . . . a preliminary series (of experiments) was undertaken in 1888, a more extended one was conducted in 1889, and the subject is being further investigated in the present year. The results so far obtained show that, when a soil growing leguminous plants is infected with appropriate organisms, there is a development of the so-called leguminous nodules on the roots of the plants, and, coincidently, increased growth and gain of nitrogen. These results were obtained after adding to a sterilized sandy soil growing leguminous plants a small quantity of the watery extract of a soil containing the appropriate organisms. There is no evidence that the leguminous plant itself assimilates free nitrogen; the supposition is rather that the gain is due to the fixation of nitrogen in the growth of the lower organisms in the root nodules, the nitrogenous compounds so produced being taken up and utilized by the leguminous plants. It would seem, therefore, that in the growth of leguminous plants, such as clover, vetches, peas, beans, lucerne, &c., at any rate some of the large amount of nitrogen which they contain may be due to atmospheric nitrogen brought into combination by the agency of lower organisms." No hint is given as to the identity of the "lower organism" so frequently mentioned, but there is reason to think that it is a fungus belonging to the class *Ustilaginæ*, which exists in and is the cause of the tubercles, or root nodules, found upon the root fibres of leguminous plants.

The bulk of the memorandum is occupied with the continuation and re-editing up to date of the results obtained at Rothamsted by the application of fertilizers. The matter is important, but as it takes the form of an annual report in which the latest results are added to and incorporated with those of previous years, already noticed by us in due course, we must refrain at the present time from more lengthy notice. Sir John Lawes has always been a stout advocate of the view that the source of nitrogen in plants was to be looked for *in the soil* and not in the air. It is, therefore, an interesting fact, as between him and the believers in the assimilation of atmospheric free nitrogen, that the micro-organisms in question seem to offer a *modus vivendi*, or means of reconciliation, between two hitherto conflicting doctrines.

[1] "Memoranda of Field Experiments at Rothamsted, Herts, conducted by Sir John Lawes, Bart." 1890.

SCIENTIFIC SERIALS.

IN the *American Meteorological Journal* for November, Prof. W. Ferrel replies to the attacks made by Prof. Hazen on Espy's experiments on storm generation. He points out that this theory does not rest upon the experiments of Espy alone, but on those of Regnault, Clausius, Sir W. Thomson, and others, all of which were finally embraced in a convenient formula by Dr. Hann, and adopted by himself (*Meteor. Zeitsch.*, 1874, and Smithsonian Report, 1877). M. H. Faye continues his articles on the "Accessory Phenomena of Cyclones." This number also contains a summary of a report by Mr. W. Ogilvie on his exploration of the Canadian Yukon, and the region between it and the Mackenzie, in 1887 and 1888, embracing some portions of country never before visited by a white man. He wintered in 1887 in lat. 64° 61′, long. 140° 54′. The maximum pressure in January reached 30·3 inches or 0·3 inch higher than the most trustworthy maximum isobars for that region. The mean minimum temperature in December was −33°·6, and the absolute minimum in the same month −55°·1. The mean temperature is not given. Drifting ice in the river commenced on October 21, the ice set on November 15, and on February 3 the thickness amounted to 48 inches. From the station on the Yukon to one on the Porcupine, lat. 65° 43′ long., 139° 43′, the following meteorological notes are given: lowest temperature in April, −37°. The last time a minus reading was recorded was May 5, −1°·8. Highest temperature in April, 40° on 30th; the highest in May, 55° on 7th. The report contains a series of notes on the opening and closing of the Mackenzie, on the duration of sunlight, and on the climate and capabilities of that region. Green clouds, a phenomenon apparently rare, were observed on the mornings of February 19 and 29 just before sunrise; at the same time there was a slight fall of minute ice-crystals.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, December 11.—"On Ellipsoidal Harmonics." By W. D. Niven, F.R.S.

In this paper some of the properties of these functions are

obtained from a discussion of their expressions in Cartesian co-ordinates.

If Θ_r denote

$$\frac{x^2}{a^2+\theta_r}+\frac{y^2}{b^2+\theta_r}+\frac{z^2}{c^2+\theta_r}-1,$$

the general expression for an ellipsoidal harmonic is given by

$$G=(1, x, y, z, yz, zx, xy, xyz)\Theta_1 \ldots \Theta_n,$$

where any of the quantities inside the brackets is the multiplier of the product of Θ's outside, provided n equations of the form

$$\frac{p}{a^2+\theta_1}+\frac{q}{b^2+\theta_1}+\frac{r}{c^2+\theta_1}+\frac{4}{\theta_1-\theta_2}+\ldots+\frac{4}{\theta_1-\theta_n}=0$$

are satisfied, p, q, r being respectively 3 or 1, according as G does or does not contain x, y, z as factors.

For the same values of θ, another function satisfies Laplace's equation, given by

$$H=(1, x, y, z, yz, zx, xy, xyz)K_1 \ldots K_n,$$

where

$$K_r-1=\Theta_r.$$

The functions (H) are spherical harmonics, and several properties of the functions (G) depend upon those of (H).

The functions (G) are applicable to the interior of the ellipsoid. Those pertaining to the exterior, as is well known, are of the form GI, where I is a certain integral depending on the quantities θ pertaining to G.

If G and H are corresponding functions of the nth degree according to the above definitions, then

$$GI=(-1)^n \frac{1}{2^n n!} H\left(\frac{d}{dx}, \frac{d}{dy}, \frac{d}{dz}\right)V_n,$$

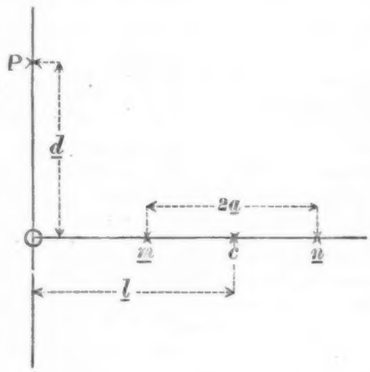
where V_n is the potential at xyz due to an ellipsoid whose density at any internal point f, g, h is

$$n\left(1-\frac{f^2}{a^2}-\frac{g^2}{b^2}-\frac{h^2}{c^2}\right)^{n-1}.$$

The remainder of the paper is occupied with the reduction and application of these results to ellipsoids of revolution.

Physical Society, November 28.—Prof. W. E. Ayrton, F.R.S., President, in the chair.—The following communications were made:—Additional notes on secondary batteries, by Dr. J. H. Gladstone, F.R.S., and Mr. W. Hibbert. After referring to the debatable points as to what compounds are formed and decomposed in the working of such batteries, the authors give the results of their examination of the red substance formed by the action of dilute sulphuric acid on minium, and which Dr. Frankland believes to be a compound having the formula $Pb_3S_2O_{10}$. The ultimate analysis showed 72 per cent. of lead. A portion of the substance was treated with a 3 per cent. solution of ammonium acetate to dissolve out any normal sulphate that might be present; this left a residue much darker in colour than the original substance, and containing 82 per cent. of lead. PbO_2 contains 86·6 per cent. of lead. The colourless solution yielded a ratio of Pb to SO_4, varying from 2·0 to 2·15; pure $PbSO_4$ requires a ratio of 2·16, and Frankland's compound 3·23. From these results the authors conclude that the portion dissolved was not a basic sulphate, and that the evidence tells against the original substance being a chemical compound. The authors have also continued their comparative experiments on the action of spongy lead on dilute sulphuric acid, either pure, or containing a small quantity of sulphate of soda. After the experiments had gone on for five months, the residues were analyzed; that from the pure acid showed 82 per cent. of lead sulphate and 18 per cent. of metallic lead, whilst that mixed with sodium sulphate gave 89 per cent. of lead sulphate and 11 per cent. of lead. They therefore conclude that although the action of acid on lead is initially diminished by the presence of sodium sulphate, the final result is rather the other way. Mr. G. H. Robertson, who had used ammonium acetate to analyze plugs from storage cells, said he had arrived at results much the same as those stated by the authors. Mr. Swinburne said Dr. Frankland was absent, but, without agreeing with him, he would suggest that Dr. Frankland might say that ammonium acetate decomposed the subsalt $Pb_3S_2O_{10}$, and then dissolved the sulphate $PbSO_4$. The question might be attacked by acting on equal quantities of the substance and the mixture PbO_2, $2PbSO_4$, in a calorimeter with ammonium acetate, to see if the same heat is produced; this would show whether the substance is a mixture or a compound. Dr. S. P. Thompson was glad that the authors allowed a possibility of basic sulphate being formed, for it was well known that an almost irreducible sulphate resulted from leaving a cell nearly discharged; this, he thought, would point to a possible formation of a basic sulphate from PbO and $PbSO_4$. Mr. Swinburne did not see where the PbO came from, except in newly pasted negatives, and he knew of no evidence of an intermediate stage of oxide on the plates. They appear to change directly to sulphate. Dr. Thompson said that a rapid discharge was known to produce basic salts. This, Mr. Swinburne thought due to deficiency of acid near the plates. Peroxide, he said, could not be formed on the negative, without the acid was heterogeneous and gave rise to local currents. Mr. W. Hibbert, referring to Mr. Swinburne's statement, said he had put one plate of spongy lead into strong acid and another into weak, and from this arrangement obtained a fairly large current. As regards the basic sulphate spoken of by Dr. Thompson, he did not think there was much probability of its being formed. Time, he said, had an important influence on a partially discharged cell, and he would not expect to easily reduce the $PbSO_4$ formed by the long-continued action of lead on sulphuric acid. The President inquired whether Mr. Hibbert's argument would apply to a fully charged cell. Mr. Hibbert, in reply, said that in this case the time required to produce sufficient sulphate to be irreducible would be very much longer, for in a partially discharged cell much sulphate was already formed. Dr. Gladstone said he had anticipated that Dr. Frankland would raise the objection referred to by Mr. Swinburne. As far as he was aware, there was no direct evidence either way, but he thought that the suggested decomposition was improbable. If he acted on a mixture of PbO_2 and $PbSO_4$, he would expect to get the results actually obtained. Mixtures, however, were difficult to deal with, and the results not conclusive, for the physical condition of the mixture was not the same as that of the actual products. Referring to Dr. Thompson's remarks, he understood that it was the basic sulphate which he (Dr. Thompson) considered irreducible. Dr. Frankland, however, believed this sulphate more easily reduced than $PbSO_4$. The President remarked that he thought Dr. Frankland had two reasons for his belief in the existence of the basic sulphates. One of these was the difficulty in reducing normal sulphate, whilst the other was based on the rapid fall of E.M.F. at a certain part of the discharge. It was at this point that Dr. Frankland thought the new sulphate formed, and to meet this argument it was necessary to find some other explanation of the rapid fall. In this connection he (the President) inquired whether there was sufficient peroxide formed on the negative plate to account for the drop. On this point Dr. Gladstone could not speak decisively.—An illustration of Ewing's theory of magnetism, by Prof. S. P. Thompson. A number of small "charm" compasses were placed together on a glass plate of an ordinary vertical attachment to a lantern. A large magnet at a distance served to neutralize the earth's field, and a coil enabled a magnetizing force to be applied in the plane of the needles. By this apparatus all the various phenomena exhibited by Ewing's model were beautifully shown on a screen. In the course of his experiments Dr. Thompson had found that when small magnets placed at moderate distances apart were used, it was much more necessary to neutralize the earth's field, in order that they might set themselves according to their mutual attractions, than when larger magnets were employed. A weak field directed the small openly spaced magnets, whereas with larger ones, their mutual actions were much more powerful. This fact may, he thought, throw some light on the molecular groupings in magnetite (loadstone). This substance exists in two forms, viz. one crystalline and the other of a heterogeneous structure. The former variety exhibits no magnetic retentiveness, whilst the latter is decidedly magnetic. As far as he was aware, no sufficient explanation had been given of the non-retentiveness of the crystalline variety. A difference in the molecular distances or groupings might account for the peculiarity. Mr. Boys said it was rather curious that Prof. Rücker had just devised a somewhat similar illustration of Ewing's theory, and he exhibited it at the meeting. It consists of little magnets made of long U-shaped pieces of watch-spring pivoted by glass caps on needle-points; the needle-points are fixed in little disks of lead stuck on a sheet of glass which forms the base of a glass box. An open helix surrounding the box serves to apply magnetic force. Mr. Swinburne called attention to two theoretical points. First as regards susceptibility (which he regarded as a mere ratio and not a property), he said that if particles of iron at a high

temperature rotate, as has been supposed, the susceptibility should be negative, and Prof. Ewing had some reason to think that this was the case. The next point concerned the loss of energy when an armature rotates in a strong magnetic field; this, he said, was known to be considerable, whereas if Ewing's theory is correct he would expect little or no loss, for all the little magnets would always put themselves in the direction of the field, and would never pass through positions of unstable equilibrium. The President said he had discussed the question of negative susceptibility some years ago with Dr. Lodge, with reference to the drop in the characteristics of dynamos, but he was not aware that any direct evidence had been obtained. Prof. Perry thought negative susceptibility might be possible in strong fields but not in weak ones. Mr. Swinburne, on the contrary, considered its existence would be more marked in weak fields. Mr. H. Tomlinson said he had tried experimentally whether the susceptibility of nickel, when heated above its critical temperature, was negative, but he had not been able to detect it, although his apparatus was very sensitive.—The solution of a geometrical problem in magnetism, by Thomas H. Blakesley. The problem referred to was the following: Given the two poles of a magnet and a straight line intersecting at right angles, its axis produced, to determine at what point this line is parallel to the field. The question is of scientific interest, because, if the point be found experimentally, the distance between the virtual poles of the magnet can be determined, whilst it is important practically from its bearing on the deviation of ships' compasses in certain cases. The instances in which it would apply are pointed out in the paper. Assuming



the points m and n (see diagram) to be the positions of the virtual poles, and P the required point, it is shown that

$$\frac{m}{(d^2+m^2)^{\frac{3}{2}}} = \frac{n}{(d^2+n^2)^{\frac{3}{2}}},$$

where

$$Om = m, \quad On = n, \quad \text{and } OP = d.$$

From this the expression

$$\left(\frac{d^2}{2mn}\right)^3 - \frac{3}{4}\frac{d^2}{2mn} - \frac{1}{4}\frac{m^2+n^2}{2mn} = 0,$$

is deduced. Now, in hyperbolic trigonometry, we have a formula

$$\cosh^3\theta - \tfrac{3}{4}\cosh\theta - \tfrac{1}{4}\cosh 3\theta = 0,$$

hence making

$$\frac{m^2+n^2}{2mn} = \cosh 3\theta;$$

we have also

$$\frac{d^2}{2mn} = \cosh\theta.$$

The value of θ can be then found by aid of the tables of hyperbolic sines and cosines compiled by the author, and published recently by the Society. The distance d can thus be determined in terms of m and n. A method of finding the point experimentally is then described, and the distance between the poles ($2a$) shown to be given by the expression

$$\frac{a}{l} = \tanh\frac{3\theta}{2},$$

where

$$\frac{l}{d} = \sqrt{\frac{\cosh 3\theta + 1}{4\cosh\theta}},$$

l being the distance Oc. The latter function can be deduced from the tables already referred to. Experiment shows that the distance between the virtual poles soon approaches the length of the magnet, as d increases. The strength of the field at P is given by the expression

$$\frac{4M}{d^3}\,\frac{\cosh^2\theta}{4\cosh^2\theta - 1}$$

where M is the moment of the magnet. This can be simplified by arranging d and l so that

$$\cosh^2\theta = \frac{5}{4},$$

and then becomes

$$\frac{5}{8}\,\frac{M}{d^3}.$$

Under these conditions

$$\frac{l}{d} = 0{\cdot}85065,$$

and therefore the angle

$$OCP = 40^\circ\ 23'\ 10''.$$

Entomological Society, December 3.—The Right Hon. Lord Walsingham, F.R.S., President, in the chair.—Dr. D. Sharp, F.R.S., exhibited specimens of *Papilio polites*, *P. erithonius*, and *Euplœa asela*, received from Mr. J. J. Lister, who had caught them on board ship when near Colombo, in November 1888. Dr. Sharp read a letter from Mr. Lister, in which it was stated that from the ship hundreds of these butterflies were seen flying out to sea against a slight breeze. Many of them, apparently exhausted by a long flight, alighted on the deck of the ship, and large numbers perished in the sea.—Lord Walsingham exhibited a coloured drawing of a variety of *Acherontia atropos*, which had been sent to him by Mons. Henri de la Cuisine, of Dijon. He also exhibited specimens of an entomogenous fungus, apparently belonging to the genus *Torrubia*, growing on pupæ (received from Sir Charles Forbes), which had been collected in Mexico by Mr. H. B. James. Mr. McLachlan, F.R.S., expressed an opinion, in which Mr. C. O. Waterhouse and Mr. G. C. Champion concurred, that the pupæ were those of a species of *Cicada*. Mr. F. D. Godman, F.R.S., said that at the meeting of the Society on October 3, 1888, he had exhibited a larva of a *Cicada* with a similar fungoid growth. —Mr. R. Adkin exhibited male specimens of *Spilosoma mendica*, Clk., bred from ova obtained from a female of the Irish form which had been impregnated by a male of the English form. These specimens were of a dusky white colour, and were intermediate between the English and Irish forms.—Mr. R. W. Lloyd exhibited specimens of *Anisotoma Triepkei*, Schmidt, and *Megacronus inclinans*, Er., collected last August at Loch Alvie by Aviemore.—Mr. Merrifield read a paper entitled, "On the conspicuous changes in the markings and colouring of Lepidoptera caused by subjecting the pupæ to different temperature conditions," in which it was stated that the results of many experiments made on *Selenia illustraria* and *Ennomos autumnaria* tended to prove that both the markings and colouring of the moth were materially affected by the temperature to which the pupa was exposed: the markings, by long-continued exposure before the last active changes; the colouring, chiefly by exposure during these last changes, but before the colouring of the perfect insect began to be visible, a moderately low temperature during this period causing darkness, a high one producing the opposite effect, and two or three days at the right time appearing in some cases sufficient. Dryness or moisture applied during the whole pupal period had little or no effect on either markings or colouring. Mr. Merrifield said he had obtained from summer pupæ of *illustraria* some moths with summer colouring and spring markings, some with spring markings and spring colouring, and some with summer markings, but an approach to spring colouring. These specimens, with enlarged and coloured photographs of them were exhibited. Mr. C. Fenn, who said he

did not agree with Mr. Merrifield's conclusions, exhibited a very long and varied series of *Ennomos autumnaria*, all of which, he stated, had been bred at the same temperature. He expressed an opinion that the presence or absence of moisture, rather than differences of temperature, was one of the principal causes of variation. The discussion was continued by Lord Walsingham, Colonel Swinhoe, Mr. Waterhouse, Mr. Jenner-Weir, Captain Elwes, Mr. McLachlan, Mr. Porritt, Dr. Mason, Mr. Goss, and Mr. Barrett.—Mr. G. T. Baker read a paper entitled "Notes on the Lepidoptera collected in Madeira by the late T. Vernon-Wollaston." The paper was illustrated by a number of figures drawn and coloured some years ago by Prof. Westwood.—Mr. Hamilton H. Druce exhibited several very beautiful species of butterflies, belonging to the genus *Hypochrysops* from the Solomon Islands and Australia, and read a paper on them, entitled "A monograph of the Lycænoid genus *Hypochrysops*, with descriptions of new species."—Mr. C. J. Gahan read a paper entitled "Notes on some species of *Diabrotica*."

Linnean Society, December 4.—Prof. Stewart, President, in the chair.—The President exhibited some eggs of the shell slug, *Testacella haliotidea*, and briefly described the habits and mode of feeding of this mollusk. He also delineated and described the feeding tract of the snail.—Mr. F. J. George exhibited an autumnal flowering form of *Mercurialis perennis*, with stems four feet in length, which he had found at Preston, Lancashire.—Mr. R. A. Rolfe exhibited and made some remarks on a coloured drawing of *Cycnoches Rossianum*, showing both male and female inflorescences on the same pseudo bulb.—Mr. J. E. Harting exhibited an immature example of Bonaparte's gull, *Larus philadelphia*, Ord, of North America, which had been shot on the Cornish coast at Newlyn on October 24 last.—Mr. T. Christy exhibited and made remarks on some coca-leaves which had been forwarded from an East Indian plantation, and which were found to be superior to any received from South America.—On behalf of Mr. H. N. Ridley, of the Botanic Gardens at Singapore, Mr. B. D. Jackson read a paper on orchids, genus *Bromheadia*, on which some critical remarks were offered by Mr. R. A. Rolfe.—The next paper was one by Messrs. J. H. Lace and W. B. Hemsley on the vegetation of British Beluchistan, illustrated by a route-map showing the district in which Mr. Lace had been collecting. Seven hundred species were catalogued, amongst which were eleven new to science. The paper was ably criticized by Mr. C. B. Clarke, and Mr. J. G. Baker made some interesting observations on the peculiar prickly character of the vegetation which predominates in the hot and dry district explored.

Anthropological Institute, December 9.—Francis Galton, F.R.S., Vice-President, in the chair.—A paper on an apparent paradox in mental evolution, by the Hon. Lady Welby, was read.—Mr. Francis Galton, F.R.S., exhibited a large number of impressions of the bulbs of the thumb and fingers of human hands, showing the curves of the capillary ridges on the skin. These impressions are an unfailing mark of the identity of a person, since they do not vary from youth to age, and are different in different individuals. There is a statement that the Chinese—who seem to be credited with every new discovery—had used thumb impressions as proofs of identity for a long time; but Mr. Galton pronounced it to be an egregious error. Impressions of the thumb formed, indeed, a kind of oath or signature among the Chinese, but nothing more. Sir W. J. Herschell, however, when in the Civil Service of India, introduced the practice of imprinting finger-marks as a check on personation. Mr. Galton's impressions were taken from over 2000 persons by spreading a thin film of printers' ink on a plate of glass, then pressing the thumb or finger carefully on the plate to ink the papillary ridges, and afterwards printing the latter on a sheet of white paper. Typical forms can be discerned and traced, of which the individual forms are mere varieties. Wide departures from the typical form are very rare.

Mathematical Society, December 11.—Prof. Greenhill, F.R.S., President, in the chair.—The following communications were made:—On the reversion of partial differential expressions with two independent and two dependent variables, by E. B. Elliott.—Newton's classification of cubic curves, by W. W. R. Ball.—On the stability of a plane plate under thrusts in its own plane, with applications to the "buckling" of the sides of a ship, by G. H. Bryan (communicated by A. E. H. Love).—On the q-series derived from the elliptic and zeta functions of $\frac{1}{3}K$ and $\frac{1}{4}K$, by Dr. Glaisher, F.R.S.—On the extension to matrices of any order of the quaternion symbols S and V, by Dr. Taber.—Steiner's poristic systems of spheres, by Prof. G. B. Mathews.

PARIS.

Academy of Sciences, Dec. 15.—M. Hermite in the chair.—The general relation of the state and increase of population, by M. Emile Levasseur. The relation is stated between the number of births, marriages, and deaths in France at different periods during this century. It appears that the proportion of suicidal deaths is increasing, although it is but 0·75 per cent. The illegitimate births amount to 7·5 per cent. in the period 1871-88, this proportion being about the mean illegitimacy of European nations. The number of male children born is known to be in excess of the number of female children; they become a minority, however, in the proportion of 57 to 61, because of the fact that the mean life of females is longer than that of men. All the statistics are graphically represented.—On the anomalous propagation of waves of sound, by M. Gouy.—On a modification of the electric gyroscope for the rectification of marine compasses, by M. G. Trouvé.—On the presence of very small quantities of aluminium in cast-iron and steel, by M. Adolphe Carnot.—On the increase of the number of red corpuscles in the blood of the inhabitants of the high plateaus of South America, by M. F. Viault.—On the development of the Copepodian parasite of Ascidiæ, by M. Eugène Canu.—On the localization of the active principle in the grain of Cruciferæ, by M. Léon Guignard.—On the structure of Peronosporæ, by M. L. Mangin.—Old observations of the vaccine tubercle of Leguminosæ, by M. Prillieux.—Synthesis of kainite and tachydrite, by M. A. de Schulten.—The depths of the Black Sea, by M. Venukof.

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